Handbook of Water Utilities, Sewers, and Heating Networks designed for Settlements in Permafrost Regions

(Translated from Russian)

Translated by V. Poppe

NSRG 70-1

NORTHERN SCIENCE RESEARCH GROUP: DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

= Reports =

HANDBOOK OF WATER UTILITIES, SEWERS, AND HEATING NETWORKS DESIGNED FOR SETTLEMENTS IN PERMAFROST REGIONS.

This work was originally published by the Krasnoyarsk Design and Research Institute for Industrial Construction, of the Ministry of Construction for Heavy Industries, USSR, Krasnoyarsk, 1967 under the title *Al'bom santekhnicheskikh kommunikatsiy naselennykh mest v rayonakh rasprostraneniya vechnomerslykh gruntov.*

Translated from the Russian by V. Poppe, Translation Section, National Research Council.

English translation edited by W. Slipchenko, Northern Science Research Group, Dept. of Indian Affairs & Northern Development

Requests for copies of this report should be addressed to the Chief, Northern Science Research Group, Department of Indian Affairs and Northern Development, Ottawa.

Issued under the Authority of the Honourable Jean Chrétien, PC., MP., BC., LL.L Minister of Indian Affairs and Northern Development.

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FOREWORD.

Over the past several decades, the Government of Canada has become increasingly involved in the provision of housing and utilities in far northern communities. The development of the technology necessary to do this is difficult and costly. As a result, careful attention is being paid to technological development in other countries faced with similar problems.

The engineering handbook translated here is based on Russian experience in the design and construction of water utilities, sewage disposal facilities, and heating networks in the Russian north. It is being published as a contribution to knowledge in the field of northern engineering.

A.J. Kerr,
Chief,
Northern Science Research Group

October 29, 1970.

TRANSLATION EDITOR'S PREFACE AND ACKNOWLEDGEMENTS.

In 1969 the Deputy Minister of the Department of Indian Affairs and Northern Development received a copy of the *Handbook of Water Utilities, Sewers, and Heating Networks Designed for Settlements in Permafrost Regions* published by the Ministry of Construction for Heavy Industry, USSR. This handbook was based on the Russian experience gained in the design, construction and operation of water utilities, sewers, and heating networks in towns and settlements in the Soviet Far North. It is divided into the following sections: introduction, general information, water utilities and sewers, methods of installation, thermal insulation of pipelines, water intakes, sewage treatment structures, and non-freezing water supply equipment.

Although the handbook was intended for Russian engineering and service personnel, it was felt that the handbook should be translated since it contained interesting and useful information about construction in the Soviet North.

I am most grateful to the Translation Section, National Research Council for allowing Mr. V. Poppe to translate this handbook. I would also like to take this opportunity to thank Mr. Poppe, who not only prepared the transcript, but helped unselfishly throughout its editing, and the people who reviewed the translation and offered invaluable assistance in improving it: Dr. J.F. Cooper, Prof. G. Ganczarczyk, Dr. G.W. Heinke, Dept. of Civil Engineering, University of Toronto, Mr. G.H. Johnston, Division of Building Research, National Research Council, Mr. B. Puziak, Dept. of Public Works, Government of the N.W.T., Mr. G.W. Rowley, Scientific Adviser, Dept. of Indian Affairs and Northern Development, and Mr. B.C. Semchuk, Technical Services Branch, Dept. of Indian Affairs and Northern Development. I am, however, responsible for the final draft, and take all responsibility for any errorrs which may have resulted.

W. Slipchenko.

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Introduction

The Handbook includes the basic designs of water utilities, sewers, and heating pipes for settlements in permafrost regions, as well as some data on water intakes and sewage treatment. The section on water intakes contains examples of structures on the shores of open water bodies. The section on sewage treatment contains recommendations for design based on investigations carried out at the Krasnoyarsk Design and Research Institute of Industrial Construction and the Leningrad Institute of Construction Engineering.

The Handbook incorporates the results of investigations carried out at the Krasnoyarsk Institute between 1960 and 1966, as well as the data supplied by the following organizations: Design Office at the Noril'sk Mining and Metallurgical Combine, Design Office of "Vorkutugol", Design Institute of Civil Engineering in Yakutsk, Institute of Construction Engineering in Leningrad, All-Union Design and Research Institute of Marine Transportation, Research Institute of Water Utilities and Sewer Systems, Design Institute of Construction in the Far North, Academy of Municipal Services, and Research Institute of Foundations and Underground Structures.

The authors have taken into account requirements given in "Instructions for the design of settlements, enterprises, buildings and other structures in the northern construction-climatic zone" (SN 353-66, Stroiizdat, Moscow, 1967) and SNiP* II-B 6-66, Chapter 6: Bases and foundations of buildings and structures on permafrost.

The Handbook contains mainly blueprints of structures used in Noril'sk, where a vast amount of experience in designing, building and operating such structures in permafrost has been accumulated in the last 25 years. This pioneering experience should always be considered in northern construction. However, the Noril'sk experience, like any other, should not be copied blindly for any settlement or town in the Far North. The choice of the type of structure, design, and method of installation should be based on comprehensive engineering and economic analyses taking into account all local conditions. It may well be that for the sake of expediency certain modifications will have to be incorporated in designs given in the Handbook.

The Handbook also contains the most widely used designs from Vorkuta, Magadan, Yakutsk, and a number of settlements and small towns in the Far North.

Together with advanced designs which make it possible to mechanize the installation work, the Handbook also contains simplified designs used in areas without an appropriate construction industry.

The Handbook has been prepared by members of the Krasnoyarsk Institute and the Noril'sk Design Office.

The sections on water utilities, sewers, heating pipes, and their installation have been compiled by V.P. Stegantsev (Krasnoyarsk Institute), L.E. Ashenkampf (Noril'sk Design Office), G.G. Reiman, and A.D. Zhmud (Krasnoyarsk Institute). The sections on the thermal insulation of pipelines and water intakes have been prepared by V.P. Stegantsev, L.E. Ashenkampf, and G.G. Reiman. B.G. Mishukov and I.P. Mochalov prepared the chapter on sewage treatment, and A.V. Lyutov (Krasnoyarsk Institute) the section on non-freezing water supply equipment.

The work was supervised by V.P. Stegantsev who was also the general editor of the Handbook. Further assistance was given by the experts from the Noril'sk combine, L.I. Anisimov (winner of the Lenin prize) and N.N. Levchenko, as well as the head of the Noril'sk research branch of the Krasnoyarsk Institute M.V. Kim (winner of the Lenin prize).

The blueprints are accompagnied by brief explanatory texts. The handbook also contains a list of the more important publications concerning the operation of pipelines under severe climatic conditions.

The designs given in the Handbook must be improved. This will require the cooperation of all specialists concerned with

*Soviet Construction Standards

design, construction, and operation of water utilities, sewers, and heating pipes in permafrost regions, and also in regions with deep seasonal freezing of soil, since in many cases the suggested designs may be applied there as well. To improve the future editions of the Handbook, all comments should be addressed to: The Krasnoyarsk Design and Research Institute of Industrial Construction, Information Section, Svobodnyi Prospekt 75, Krasnoyarsk – 62, U.S.S.R.

I. General

The design of water utilities, sewers, and heating networks described in this handbook may be used in towns and settlements in the permafrost regions, and in some cases in regions with deep seasonal freezing of soils. These designs have not been tested in seismic permafrost regions and therefore construction in such regions should be carried out with allowances for the requirements given in Sni P. II -A 12 - 62.*

There are two principles involved in using soils as foundations for water utilities, sewers, and heating networks.

Principle I: foundation soils are kept frozen throughout the entire operational period of the systems.

Principle II: foundation soils are used in a thawing or thawed state.

The choice of the principle used depends on the permafrost, geological, hydrogeological, and climatic conditions at the construction site. Furthermore allowances should be made for the overall plan of construction, types of foundations under buildings and other structures, and the following specific conditions:

a) the necessity to control the thermal and hydraulic regimes of pipelines to prevent them from freezing;

b) the thermal effect of pipelines on the surrounding soils during construction and operation;

c) the thermal effect of pipelines on the foundations of adjacent buildings and structures;

d) the stability of pipelines during thawing and freezing of foundation soils;

e) the thermal and erosive effects of water and sewage in case of mechanical breakdowns.

*Soviet construction Standards

Principle I is followed if soils settle on thawing. The water and sewer pipes are installed as follows:

a) above ground – on supports, trestles, and in ventilated crawl spaces;

b) on the ground – in embankments and on the surface of the ground;

c) underground – usually in ventilated conduits.

d) Along the route of the conduit, the ice-saturated soils and soils subject to settlement are replaced to the estimated depth of thawing by soils not subject to settlement.

Principle II is used in the presence of soils which do not settle on thawing and in all cases where the use of Principle I is not absolutely essential.

The water utilities, sewers, and heating networks are designed in conjunction with the overall construction plans, and organization of public services and amenities. This should involve the following:

a) the simplest operational systems with adequate reserves;

b) materials, equipment, and structures which are stronger and more durable than those used under normal conditions;

c) maximum use of remote-control measurements and automatic equipment;

d) joint installation of the largest possible number of pipelines and cables with provisions for appropriate sanitary, safety, and special standards and requirements;

Use should be made mainly of steel pipes with special fittings which do not freeze.

In joint installations, water, sewer, and heating pipes, as well as various cables, are installed in conduits. The ventilation of conduits together with insulation of pipes reduces the size of taliks (thawed zones) which invariably are formed around the conduits.

On selecting the method of sewage treatment from residential buildings, allowance should be made for the effect of low

temperatures on the rate of self-purification of water in basins, lakes, and rivers. Biological treatment of sewage should be carried out under artificial conditions. It is possible to use the sewage sludge for agricultural purposes.

As a rule, treatment plants should be located in heated buildings. Construction of unhoused treatment facilities is permitted only if the flow of sewage is considerable and if such construction is justified by appropriate calculations.

II. Water mains, sewers, and heating networks

Water mains

The choice of the layout (loop or bleed-off) is based on appropriate calculations. The main requirements are reliability and continuity of operation under the most severe permafrost, meteorological, and hydraulic conditions.

The water mains must be prevented from freezing by continuous circulation of water in all sections of the system. It should be considered that in a loop system the water consumption invariably is drastically reduced in some sections and the rates of flow approach zero. In such cases it is essential that special measures be adopted to protect the system from freezing.

In a bleed-off system it is possible to ensure constant movement of water by permitting continuous consumption or discharge of water at dead ends. If the cost of water is high and supply is limited, it is desirable to avoid wastage of water. In this case the water should be returned to the pumping station through a return flow pipe. It is recommended that large steady consumers of water be located at the end of a bleed-off system.

It is possible to install a combined system in which water is made to move either in a loop or a bleed-off system by opening or closing valves. In a bleed-off system, water is discharged into a reservoir, heated if necessary, and then returned to the system. In case of a fire the valve leading to the reservoir is closed and water moves in a loop. The reservoir serves as a storage tank for both domestic needs and fire emergencies. A combined system is recommended if the water supply is limited and buildings are closely spaced.

In Canada and Alaska use is made of a two-pipe system with recirculation of water. Such a system has proven reliable but it requires twice as many pipes with a corresponding increase in heat losses. It may be recommended also only when buildings are closely spaced and water consumption is low.

Pipe installation. The main principles of pipe installation are given in Section I. The methods are chosen on the basis of pipe diameter, water temperature, hydraulic regime, permafrost conditions, and type of construction site.

The water pipes on the surface of the ground are provided with reliable insulation. Considering the high cost of water heating, it is expedient to provide extra insulation.

The pipes may also be installed underground, close to the surface, on well compacted soil, or a clay-gravel* pad. This method is more advantageous than a surface installation, because heat losses are greatly reduced and natural soil or snow may serve as insulation. Furthermore the area does not become cluttered.

In Vorkuta the water mains are installed next to conduits containing both electric and telephone cables, or next to conduits with heating lines. This reduces the construction costs and eliminates the danger of water freezing in the system.

In towns and settlements with closely spaced buildings, it is best to install the water supply system in accessible** conduits of reinforced concrete (see section III).

The points at which the water pipes enter the buildings are the most likely places where freezing may occur, if water consumption is low and intermittent. On the other hand, the thermal effect of such places on the perennially frozen foundation soils may disturb the stability of foundations which are designed to preserve the permafrost. Special attention should be given to complete elimination of water seepage into the soil and thawing of soil around the pipe. The number of building connections should be kept to a minimum.

If building connections are in conduits, they should slope away from the buildings and towards the main water line, to ensure that in the case of breakdown or thawing of soil the water would flow away from the building. In Canada and U.S. if

*Clay reinforced with gravel (40%), coarse-grained sand (25%), and fine-grained sand (15%). See diagram III-I, sections 6 & 10.

**In the sense that one can walk through them.

water lines to buildings are installed separately from other utilities (either underground or in boxes on the surface of the ground) they are heated by an electric cable. The best operational conditions are achieved if all services to a building are placed in ventilated conduits.

Large mains transporting water from its source to towns and settlements are usually installed above the surface of the ground. If permafrost conditions are favourable, pressurized and gravity flow pipes may be installed in the ground. The shape of cross-sections of gravity systems (conduits, troughs, etc.) may vary. Preference should be given to narrow cross-sections, because heat losses will be smaller. An appropriate hydraulic regime and adequate insulating soil layer above a gravity water line may create a steady water temperature in the line regime such that heating is not required. This may be achieved due to heat of hydrodynamic friction, even if the temperature of water at its source is close to 0°C.

In pressurized water lines allowance should be made for the uneven build-up of ice in the line throughout its length.

Instrumentation. The design of water supply lines should include provision for installation of control and measuring instruments for a continuous check of hydraulic, temperature, and ice regimes. The data obtained in this way make it possible to select the most economical operating conditions and reduce the power used for heating the water, and in some cases eliminate it completely. It is recommended that automatic equipment, which gives a signal when temperatures drop to a critical point, and automatically starts a heating device or opens valves, be installed.

Sewers

The main type of sewer system used in permafrost regions is a separate system with pipes for the removal of domestic sewage and contaminated industrial wastes. Surface run-off and relatively unpolluted industrial waste may be removed by means of surface systems (troughs, ditches, etc).

Plants and facilities continuously discharging large volumes of sewage should be located, if possible, near the high end of the sewer systems, to ensure a continuous flow through the system. It is also essential to locate the plants and facilities discharging warm sewage (public baths, laundries, industrial enterprises, etc.) on the initial sections of the system to prevent the pipes from freezing.

In calculating the volume of sewage in the system, allowance should be made for water bled from the water supply system to prevent the latter from freezing. This may amount to 10 – 15% of the total volume of sewage.

When designing a sewer system it is essential that the drop in temperature of sewage throughout the length of the pipeline and the temperature at various points on the line be calculated.

The location of surface drains and ditches and the structural designs of overpasses should be such as to eliminate the thermal effect of surface water on the foundation soils under adjacent buildings and structures.

If it is not possible to ensure a continuous flow of sewage in some sections of the system, then such sections should be protected by one of the following measures:

a) the installation of sewer and heating pipes in a common conduit or special ducts;

b) the installation of the sewer pipe in the thawed zone next to the heating conduit;

c) the installation of the pipe in a conduit with special heating arrangements;

d) electric heating;

e) additional discharge of hot water from the water supply system.

Steel pipes and also cast iron pipes are used for sewer lines if ground conditions permit.

It is recommended that bell and spigot joints and coupling joints on gravity sewers be sealed with elastic materials (tar impregnated jute packed and sealed with asphalt mastic, etc.)

As a rule sewers in settlements are installed underground. Outside the settlements the pipes may be installed on or above the surface of the ground.

The sewer-house connections in buildings are suspended from the basement ceiling or are installed in ventilated conduits.

The depth of installation of underground pipelines should be kept at a minimum, and should be calculated with allowances for the dynamic loads from traffic and other factors.

On sites with favourable ground conditions, where construction may be carried out without retention of permafrost, pipes of any diameter may be installed in a conventional way.

Manholes in sewer systems may consist of prefabricated rings. The sub-base underneath the manhole should be insulated with a clay-gravel mixture and the backfill around the manhole should consist of non-frost susceptible material.

The manhole should be covered with two insulated lids.

The design of sewers should call for closed systems with access for testing the sewer lines through manholes. A closed system is used also in the case of joint installations of several services in one conduit.

If ground conditions are favourable, the sewer pipes may be laid directly on the natural ground or in embankments.

If required (and confirmed by calculations), sewer pipes installed on or above the surface of the ground are provided with insulation.

Heating lines

Heating lines have large heat losses and thus have a great effect on their foundation soils, as well as those of adjacent buildings and structures. Therefore preference should be given to heating lines installed above the surface of the ground.

Underground installation is recommended only in the case of joint installation of various systems and, as a rule, in accessible conduits. Installation in inaccessible conduits is possible only if the ground conditions are favourable, and for short sections of the line, e.g. building connections and road crossings. The heating lines should located in the upper parts of conduits.

Underground installation of heating lines in permafrost without conduits is not permitted. The number of building connections should be kept to a minimum and it is absolutely essential that water at gate valves should be continuously circulating. It is recommended that expansion joints and elbows be used. Gasket expansion joints may be used with pipes exceeding 350 mm in diameter. The use of locks, control fittings, gaskets, expansion joints, discharge taps, and air taps is not permitted on sections installed in ventilated crawl spaces.

Planning of built-up areas with considerations for the routing of water lines, sewers, and heating networks

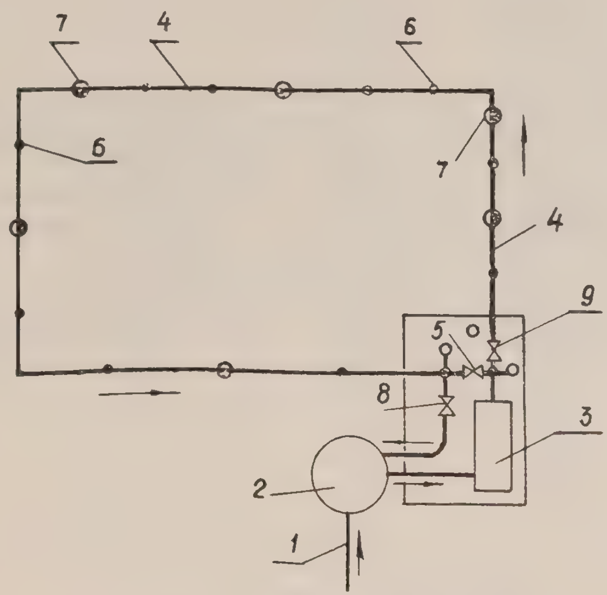
The plans of settlements usually call for small separate blocks with buildings located along the perimeter of the block and only a few isolated buildings in the center of the block.

To a considerable extent, such plans of towns and settlements predetermine the location of water lines, sewers, and heating networks along the streets and thoroughfares; in itself this is the best way to ensure that heating mains which have large heat losses are at a maximum distance from the buildings and do not have any marked effect on the thermal regime of their foundation soils. In such cases almost every building has its own house connections. The length of pipe and house connections per sq. m. of living space in a given block of buildings, e.g. Noril'sk, is 0.032 and 0.016 linear meters respectively.

The tendency since 1957 has been to provide one house connection for several (2-3) buildings. Thus the length of pipes and house connections per sq. meter of living space can be reduced to 0.027 and 0.015 linear meters respectively. In Noril'sk the unit length of pipes and house connections has been reduced by 17.38% and 12.38% respectively.

Changes in town planning concepts, which involved the erection of large groups of buildings (microareas), brought about changes with respect to the location of buildings. It is now possible to adopt joint installation of services for a group of buildings by locating them in basements of adjacent buildings and connecting them to the mains by means of one connection.

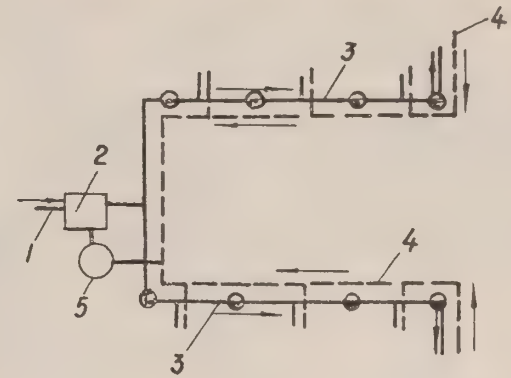
The microarea concept in town planning makes it possible to reduce still further the specific amount of service lines per sq. meter of living space.



Combined (bleed-off and loop) system.

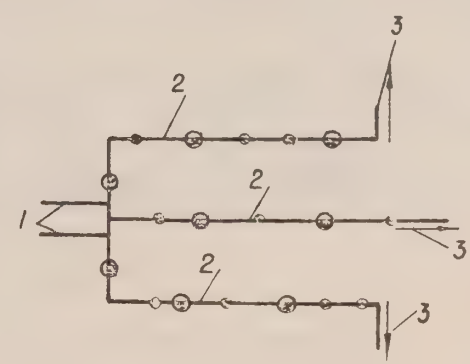
1. from water source;
2. reservoir;
3. pumping station for circulating heated water;
4. water supply lines;
5. valve;
6. hydrant;
7. fire hydrant;
8, 9. valves.

Normal operation: valve 5 is closed, water is discharged into the reservoir. In case of fire: valve 5 is opened, valve 8 is closed, water flows to the point of fire from two sides (a loop system is formed).



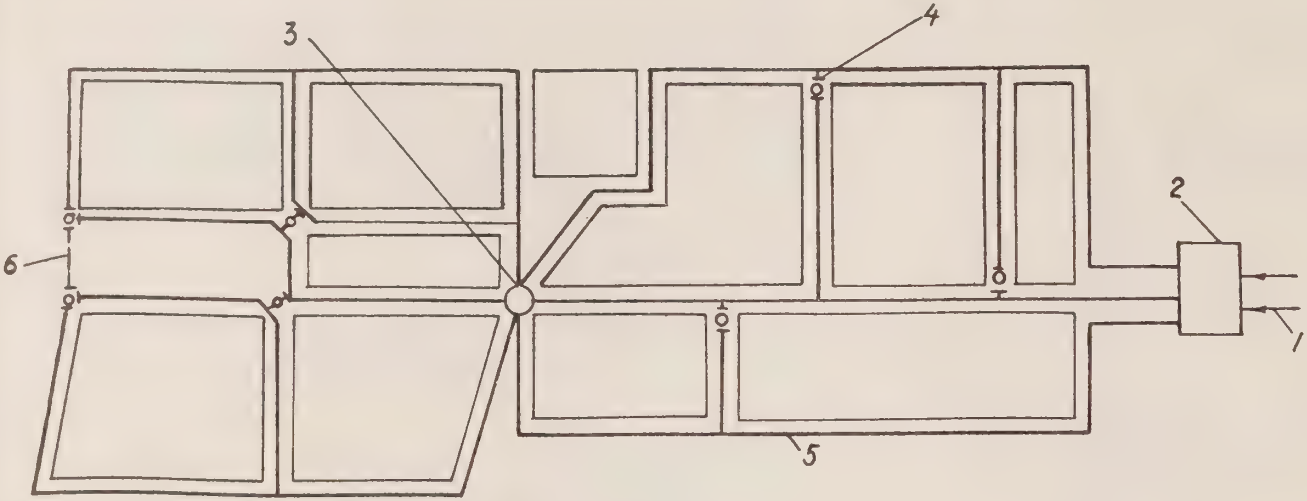
Bleed-off system with circulation of heated water.

1. from water source;
2. pumping station for circulating heated water;
3. outgoing line;
4. incoming line;
5. reservoir.



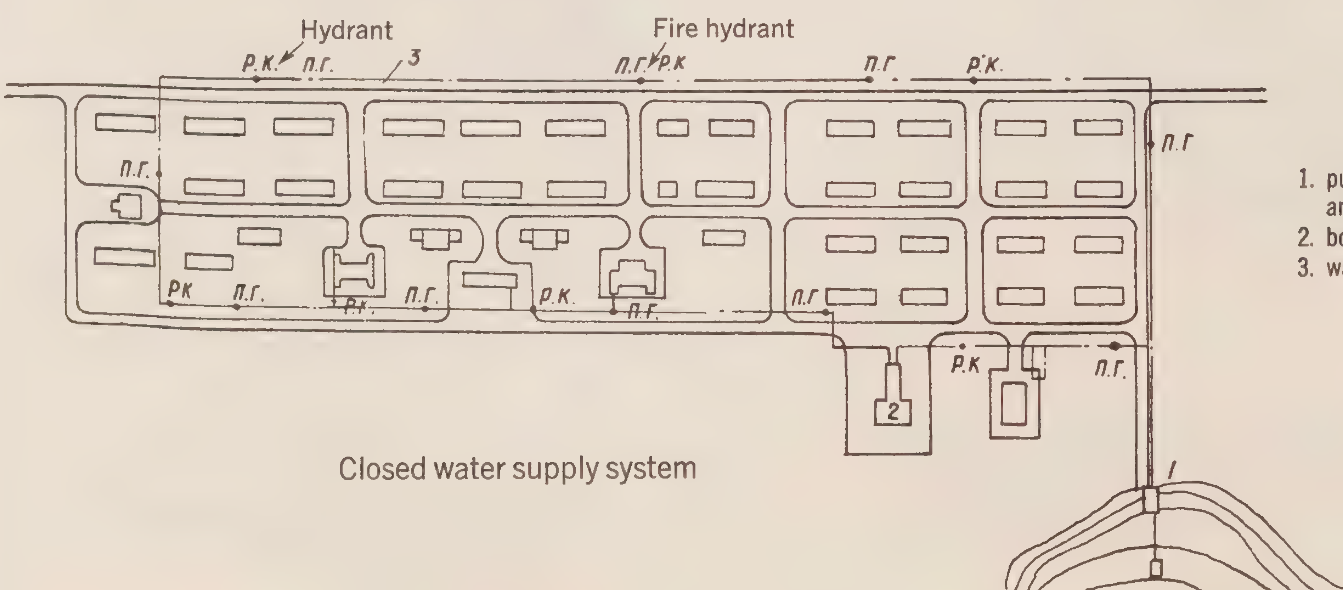
Distribution system with discharge at the terminal end to sewers.

1. from water source;
2. water supply line;
3. discharge into sewers.



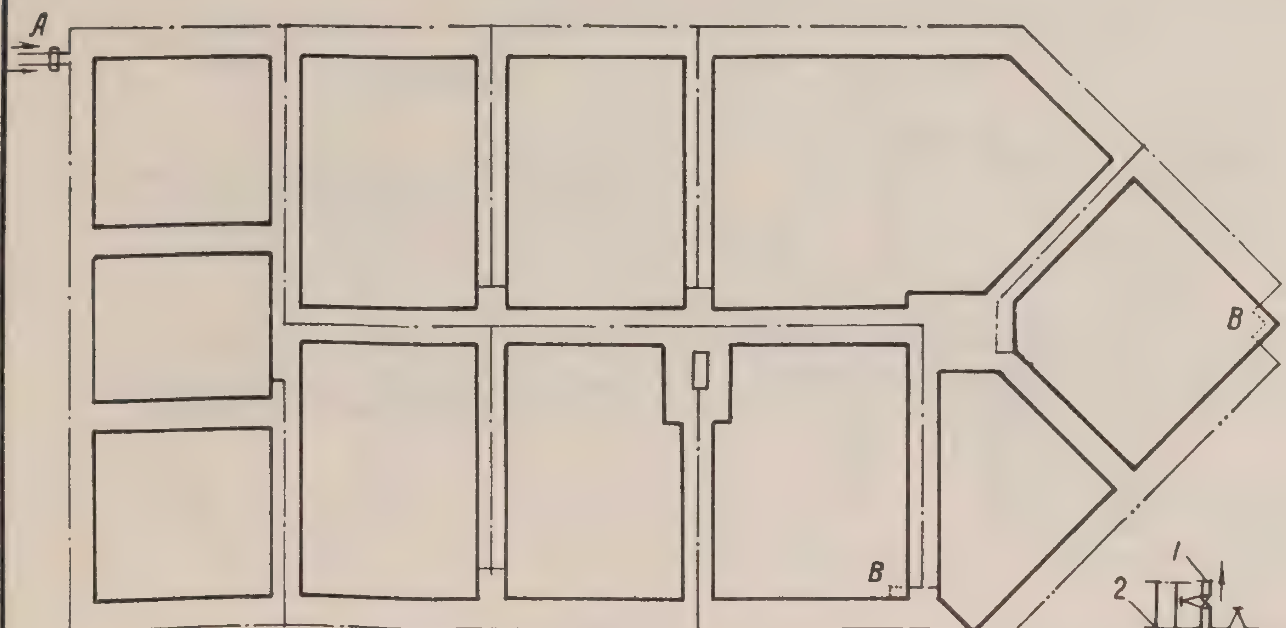
1. from pumping station on the shore;
2. purification plant, pumping station, heating plant;
3. water tower, heating plant, pumping station for circulating water;
4. diverting point;
5. water supply line;
6. section with electric heating.

Example of water supply to two town zones



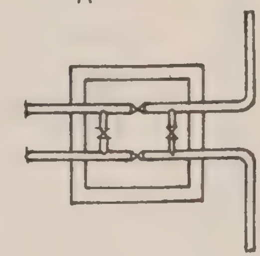
1. pumping station, heat exchanger, and chlorination plant;
2. boiler house;
3. water supply line.

Closed water supply system

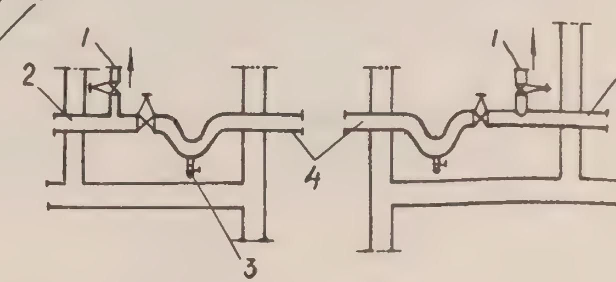


Branching bleed-off system.

A

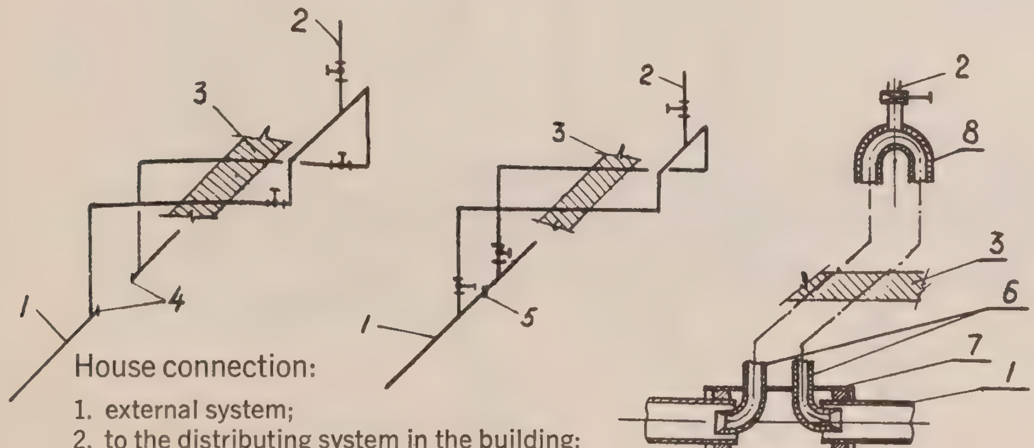


B



Joining of "dry" pipelines to the system.

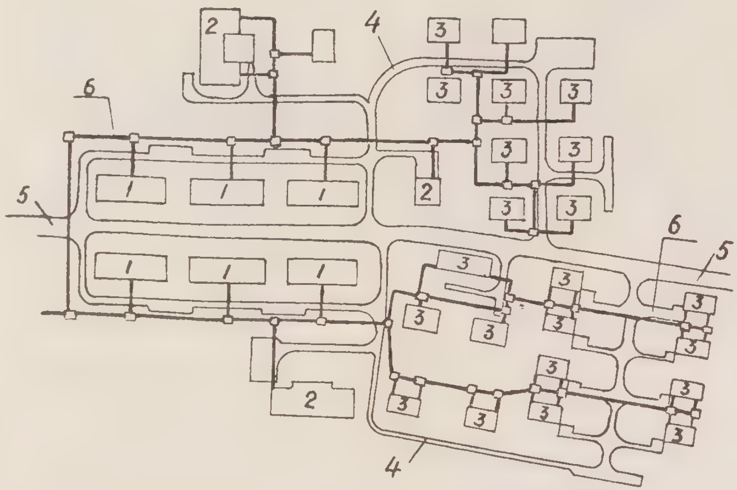
1. to internal system;
2. to external system;
3. control tap;
4. dry pipe.



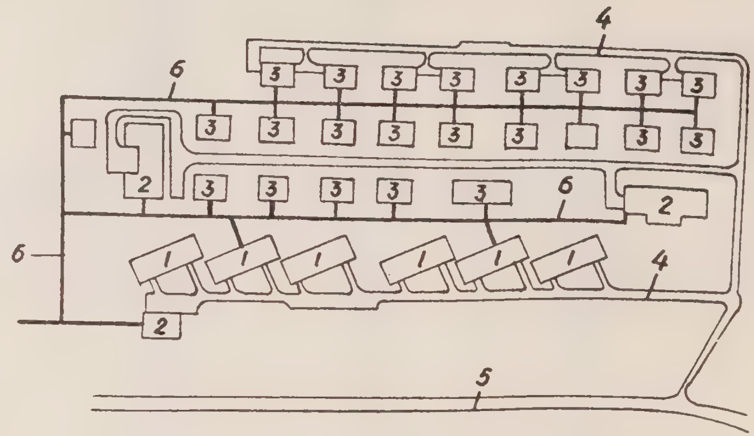
House connection:

1. external system;
2. to the distributing system in the building;
3. wall of building;
4. plugs;
5. diaphragm;
6. diverter fittings;
7. coupling;
8. diverter fittings.

Plan A



Plan B

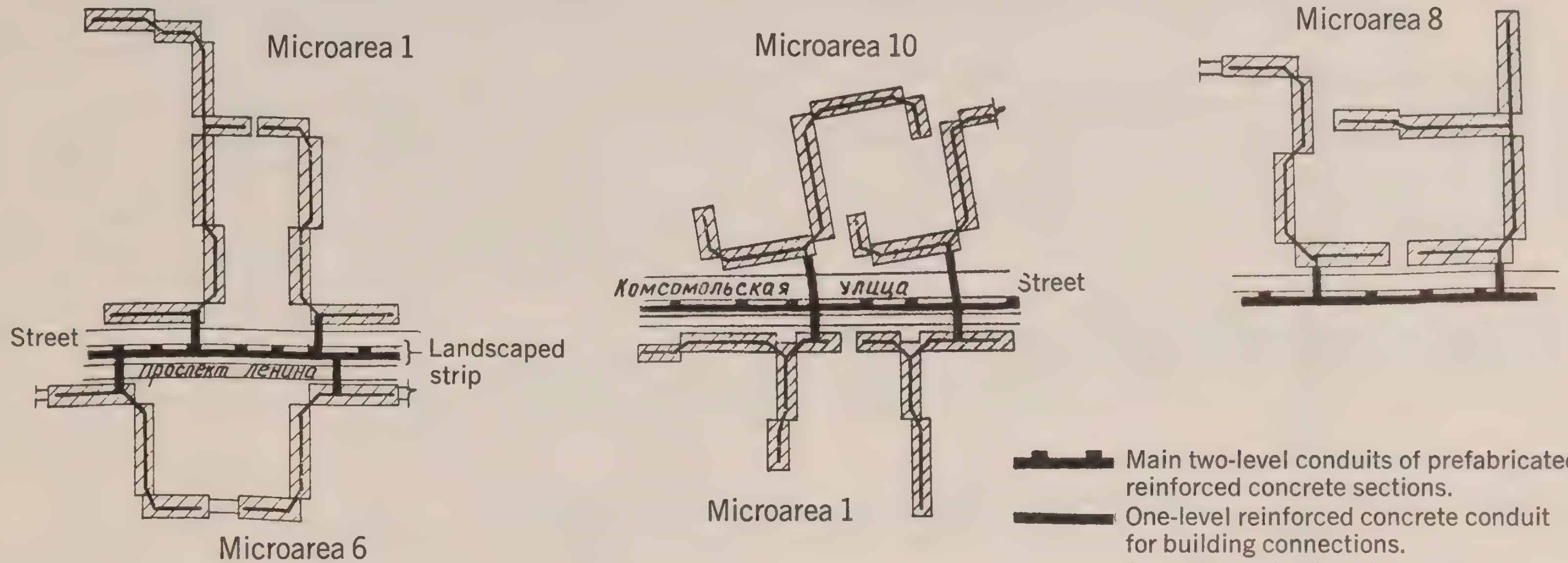


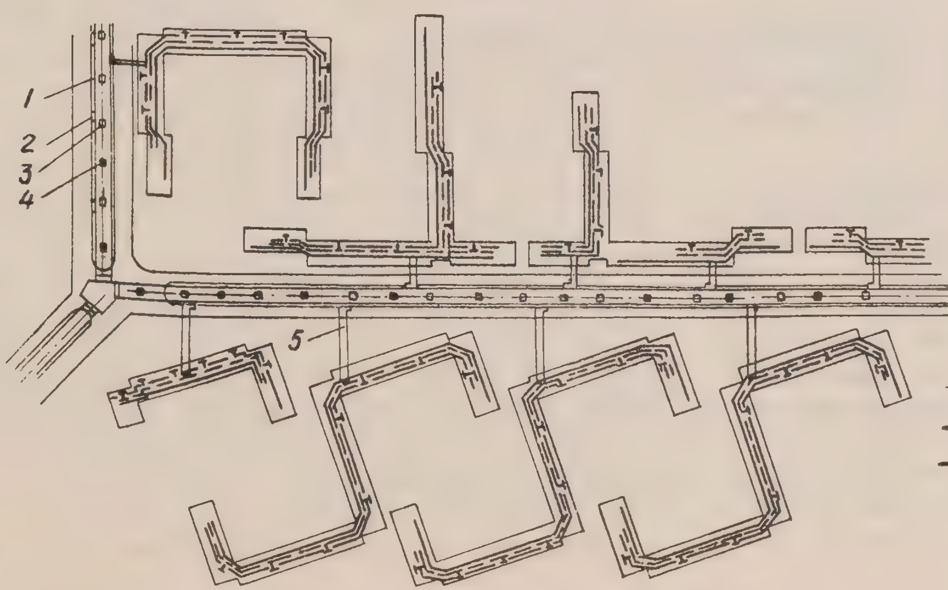
1. residential buildings (stone);
2. public buildings;
3. residential buildings (timber);
4. driveways;
5. main highway;
6. service lines.

Comparison of Plans A and B.

Length of service lines in Plan A: 1,448 m
Length of service lines in Plan B: 1,060 m
Difference: 388 m or 26.9%

Branching of Water and Sewer Lines in Crawl Spaces and Accessible Conduits (Noril'sk)	II – 5

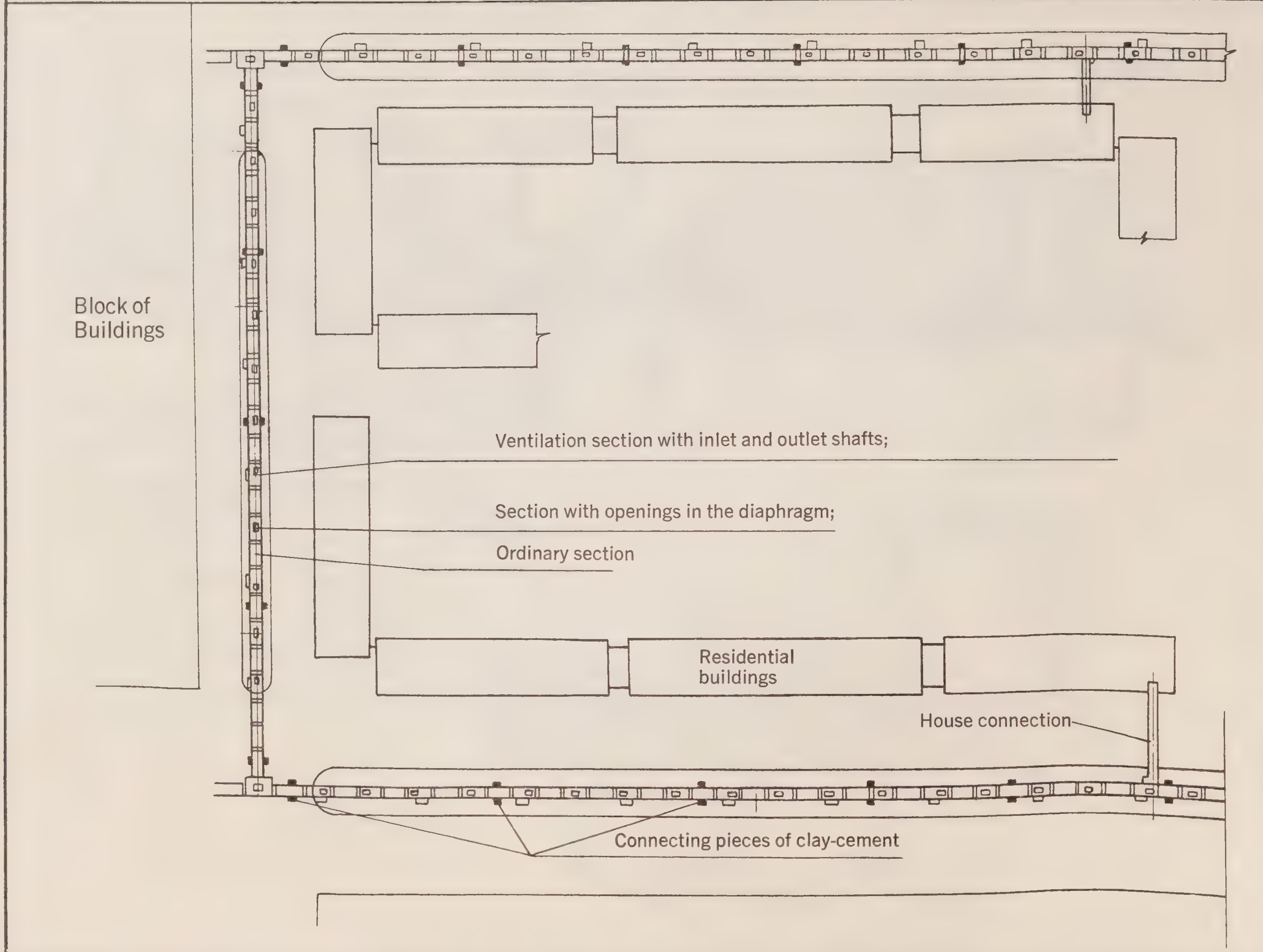




1. accessible two-level conduit;
2. inlet shaft;
3. outlet shaft;
4. opening in the diaphragm between the levels;
5. building connection.

sewer
water-main
heating line.

Layout of prefabricated conduits for a block of buildings (Noril'sk) | II – 6



III. Methods of installing water mains, sewers, and heating networks

It is essential to tie in the installation of utilities and services with the general scheme of construction of buildings and other structures. The utilities and services are installed either jointly or separately.

Separate installations are used mainly in small settlements. In towns with compact arrangements of multistorey buildings it is much more expedient to use joint installations.

In separate installations the pipes are laid on the surface of the ground on supports or soil embankments, or are buried at a shallow depth (within the layer of seasonal freezing) on pads of compacted soil or clay-gravel mixture.

In the case of surface installations it is recommended that the pipelines follow the topography as closely as possible, that the amount of excavation work be kept to a minimum, and the vegetation cover be retained. The height of installations is chosen in relation to the depth of snow: the thicker the snow cover, the smaller the heat losses. However, deep snow exerts great pressure on the pipes, which makes it necessary to reduce the spans between the supports.

Surface installations are used mainly outside the built-up areas. It is essential that the pipes be insulated, either by enclosing them in wrappings (slag, mineral wool, wooden staves, special shells, etc.) or in timber boxes with additional insulation. The installation must be made watertight. It should be noted that existing methods of insulating pipes are still inadequate, insulation is not effective when wet, is easily damaged, and takes a long time to install. Surface pipelines may be laid on fill placed on top of undisturbed vegetation cover. The most commonly used supports are timber cribs, which allow the pipelines to be adjusted in case of settlement.

In the Far North pipelines laid on the surface of the ground represent the most economical type of installations. The pipes may also be installed in soil embankments. This method is fairly common. It eliminates the use of supports or insulation. The embankments clutter the area, however, and overpasses must be provided at road crossings. Hence this method should be used outside the built-up areas only. Occasionally, because of the topography or at crossings over roads and ravines, the pipelines must be installed high above the surface of the ground on piles or trestles.

Underground installations are used within the settlement to improve the appearance of the area. Deep burial is undesirable; it increases the construction costs and complicates maintenance, especially in winter. To prevent the degradation of permafrost, a layer of clay-gravel mixture should be placed under the pipes. The thickness of the layer should be specified in the design.

Joint laying of pipes for various services has the advantage over laying them separately in that it simplifies construction, reduces the amount of work, and facilitates operation and maintenance.

Various service pipes may be laid together on the ground, on supports above the ground, or underground in accessible or inaccessible conduits.

The pipelines installed on or above the surface of the ground must be provided with reliable insulation in the form of wrappings or wooden boxes. The insulation may protect individual pipes or all pipes together.

The pipeline supports may be in the form of wooden or reinforced concrete supports, cribs, piles or posts, trestles, soil prisms, or embankments.

The installation of pipelines in underground conduits involves large capital costs but is the most advanced and expedient construction method in towns and large settlements with compact layouts of multistorey buildings.

The pipes may be laid together in one- or two-level conduits. Two-level, accessible and inaccessible conduits have proved themselves well at Noril'sk and are widely used there.

The advantages of such conduits are as follows:

1. The conduit and the surrounding buildings remain stable owing to formation of a year-round constant temperature regime in foundation soils beneath the conduit.

2. An integrated design may be used for all services and utilities, i.e., heating pipes, hot and cold water supply, sewer pipes, power cables and telephone lines.

3. The water supply and sewer pipes may be installed separately, as required by sanitary and engineering standards.

4. There is ready access to all services and ease of maintenance.

5. All construction work is fully mechanized and use may be made of prefabricated reinforced concrete components.

6. The crossings over roads and connections to consumers on both sides of the conduit are relatively simple.

Two-level conduits are the most stable; their thermal effect on the foundation soils is much smaller than that of one-level conduits. The sewers and electric cables are located on the lower level, while the heating tracer lines and the water supply are on the upper level.

The main conduits and the building connections are assembled from reinforced concrete components. One-piece reinforced concrete structures are used on road crossings only.

Inaccessible conduits up to 0.9 m in height are used on short sections (road crossings, entrances to buildings, etc.) and are installed underground as close as possible to the surface of the ground (measured from the top of the conduit). They are provided with a removable cover to facilitate cleaning and maintenance. The cover may be located directly at the ground surface. For water drainage purposes, the slope of the conduit should be at least 0.007.

The dimensions of accessible conduits should be such as to make them readily accessible for construction work and maintenance; they should be at least 1.8 m high.

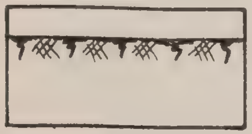
It is essential to eliminate or reduce the thermal effect of pipelines on foundation soils to prevent them from thawing. This is achieved by insulating the pipelines, ventilation, and waterproofing the bottom of the conduits.

The soils subject to settlement must be replaced where thawing is likely. The conduits are provided with either natural or forced ventilation. Preference should be given to natural ventilation which would ensure the removal of heat in winter, so that soil which had thawed in the summer would freeze completely in winter. Natural ventilation is accomplished through special openings or shafts in the roof of the conduit, with distances between them ranging from 20 to 100 m depending on the size of the conduit, the amount of heat emitted by the pipes, and their location.

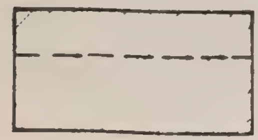
In case of accidental or emergency breaks water should be removed to low lying areas, or pumped out at the end of the lines and from intermittently installed water collectors, depending on the layout of the conduit.

Symbols Used

III – 1

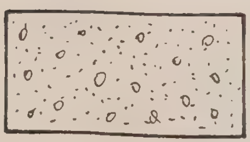


1. ground surface

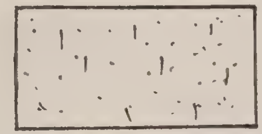


2. permafrost table

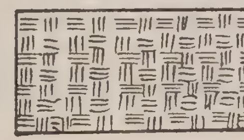
3. local soil



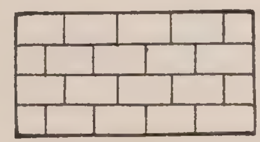
4. sandy soil with gravel



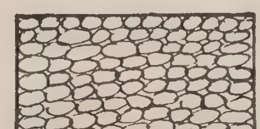
5. special back fill



6. clay-gravel mixture



7. rock



8. crushed rock

9) B. water-mains

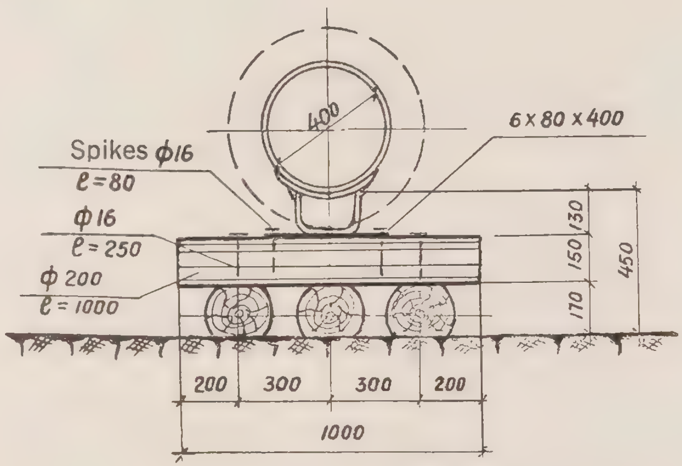
K. sewers

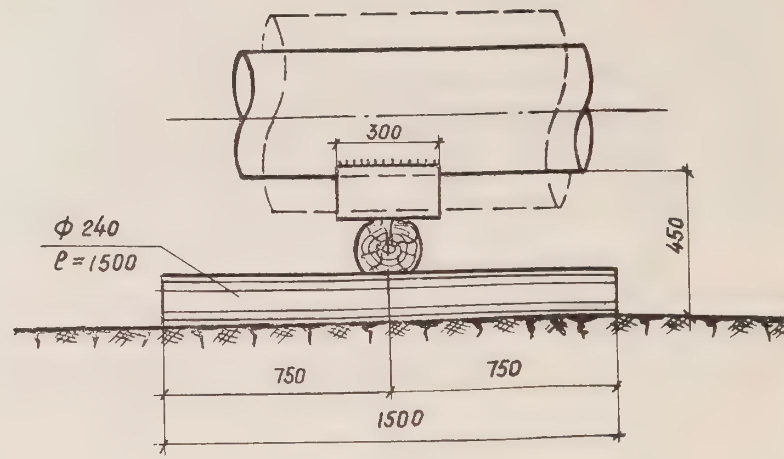
T. heating line

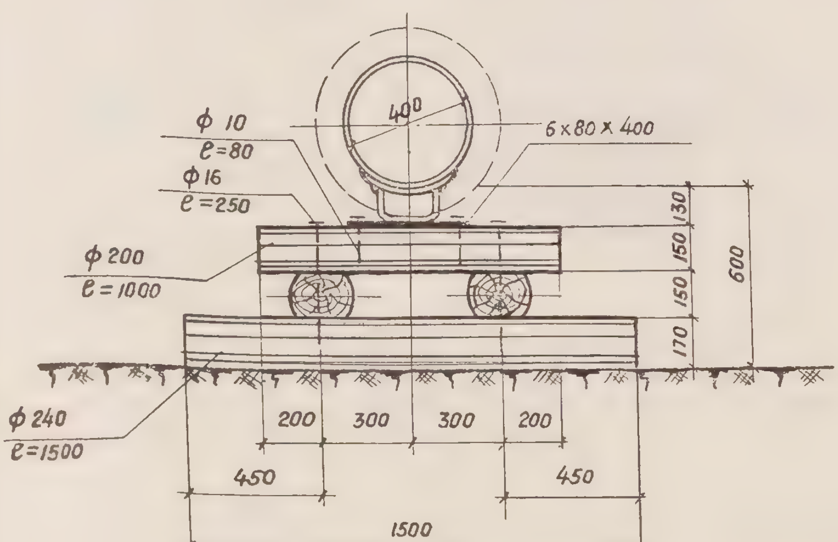
10) Composition of clay-gravel

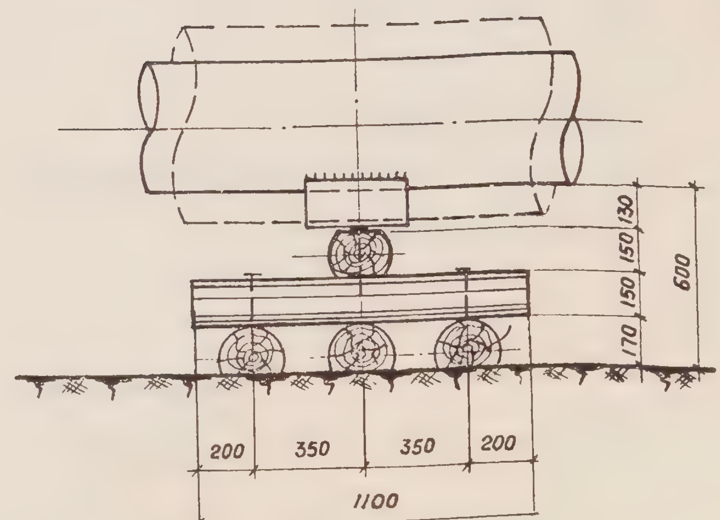
gravel and pebbles	40%
coarse-grained sand	25%
fine-grained sand	15%
clay	20%
water	200 kg/m^2

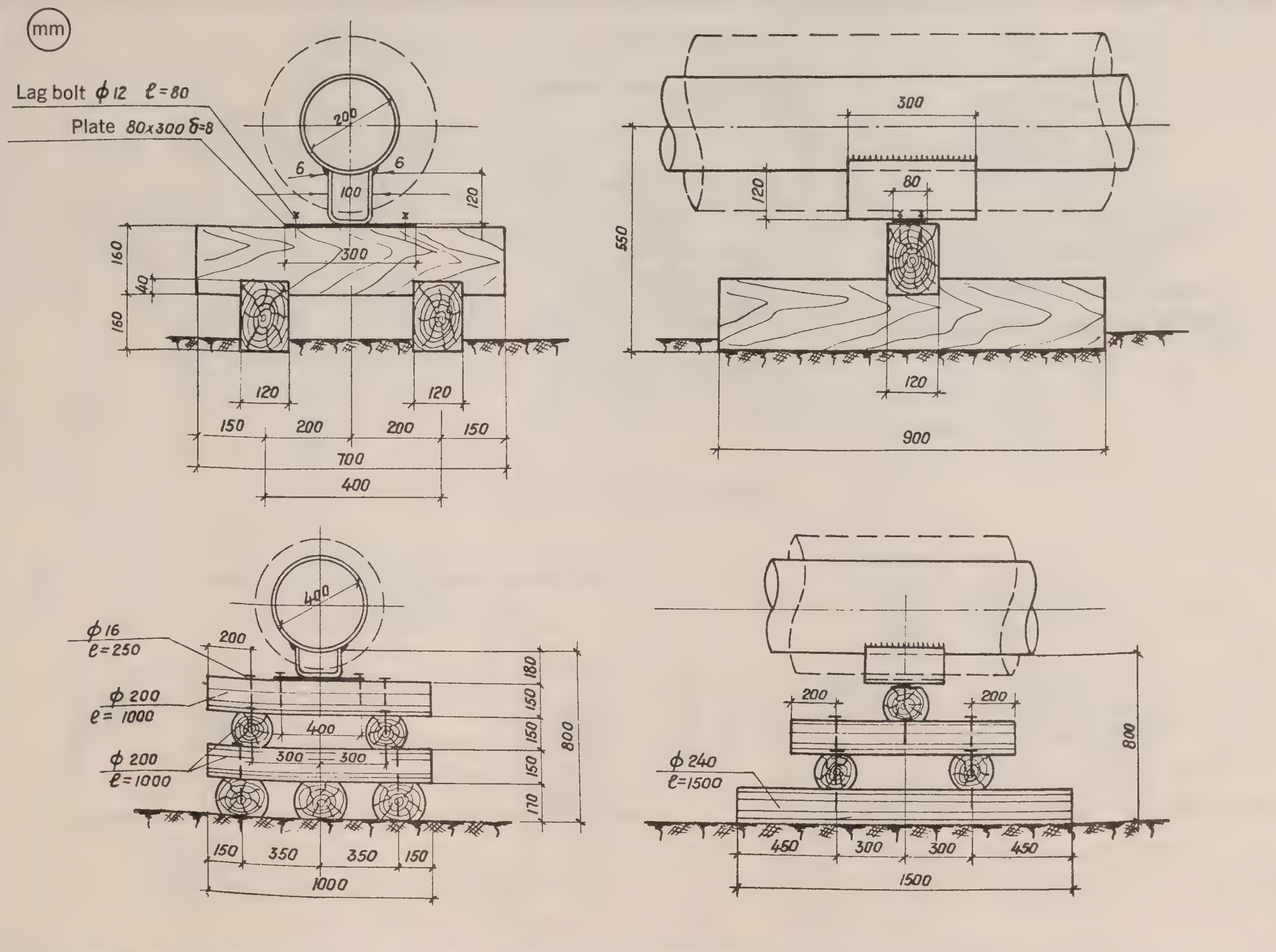
mm


400
6 × 80 × 400
Spikes ϕ16
ℓ = 80
ϕ16
ℓ = 250
ϕ 200
ℓ = 1000
130
150
170
450
200
300
300
200
1000

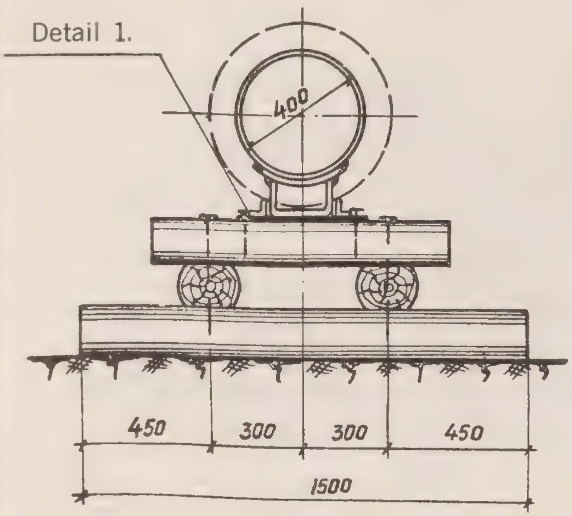

300
ϕ 240
ℓ = 1500
450
750
750
1500


400
ϕ 10
ℓ = 80
6 × 80 × 400
ϕ 16
ℓ = 250
ϕ 200
ℓ = 1000
130
150
150
170
600
ϕ 240
ℓ = 1500
200
300
300
200
450
450
1500

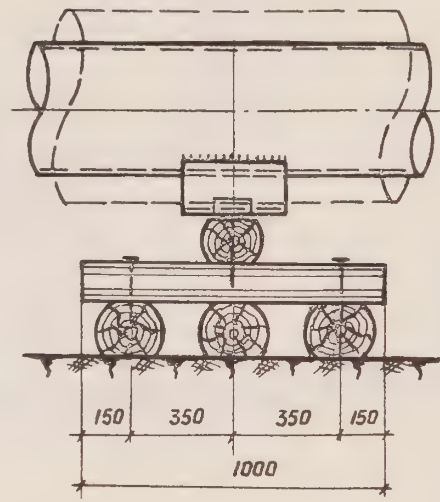

130
150
150
170
600
200
350
350
200
1100


mm
Lag bolt ϕ12 ℓ=80
Plate 80x300 δ=8
ϕ16
ℓ=250
ϕ200
ℓ=1000
ϕ200
ℓ=1000
ϕ240
ℓ=1500

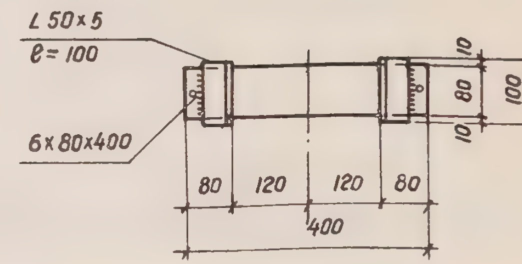
(mm)



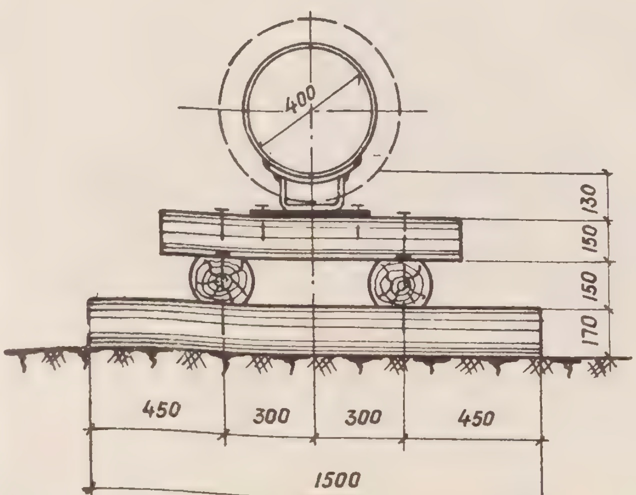
Intermediate Support

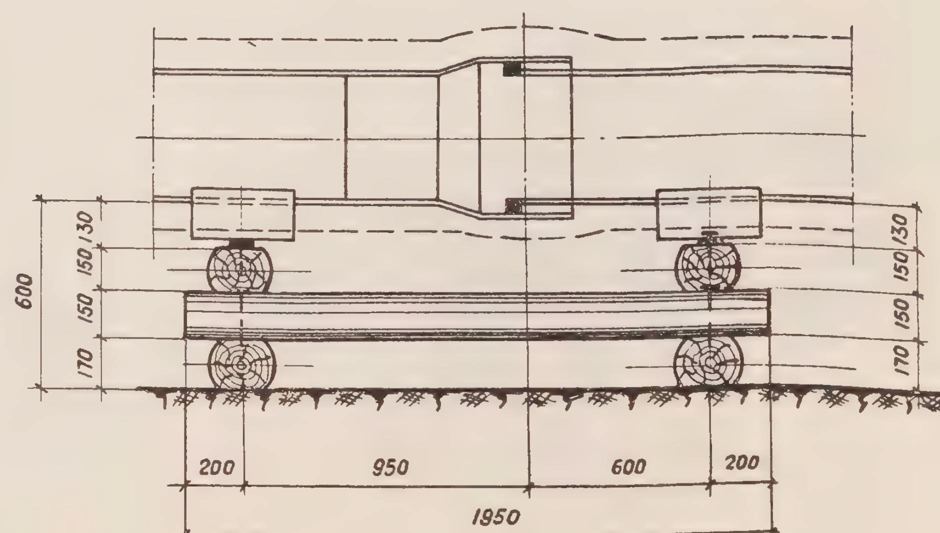


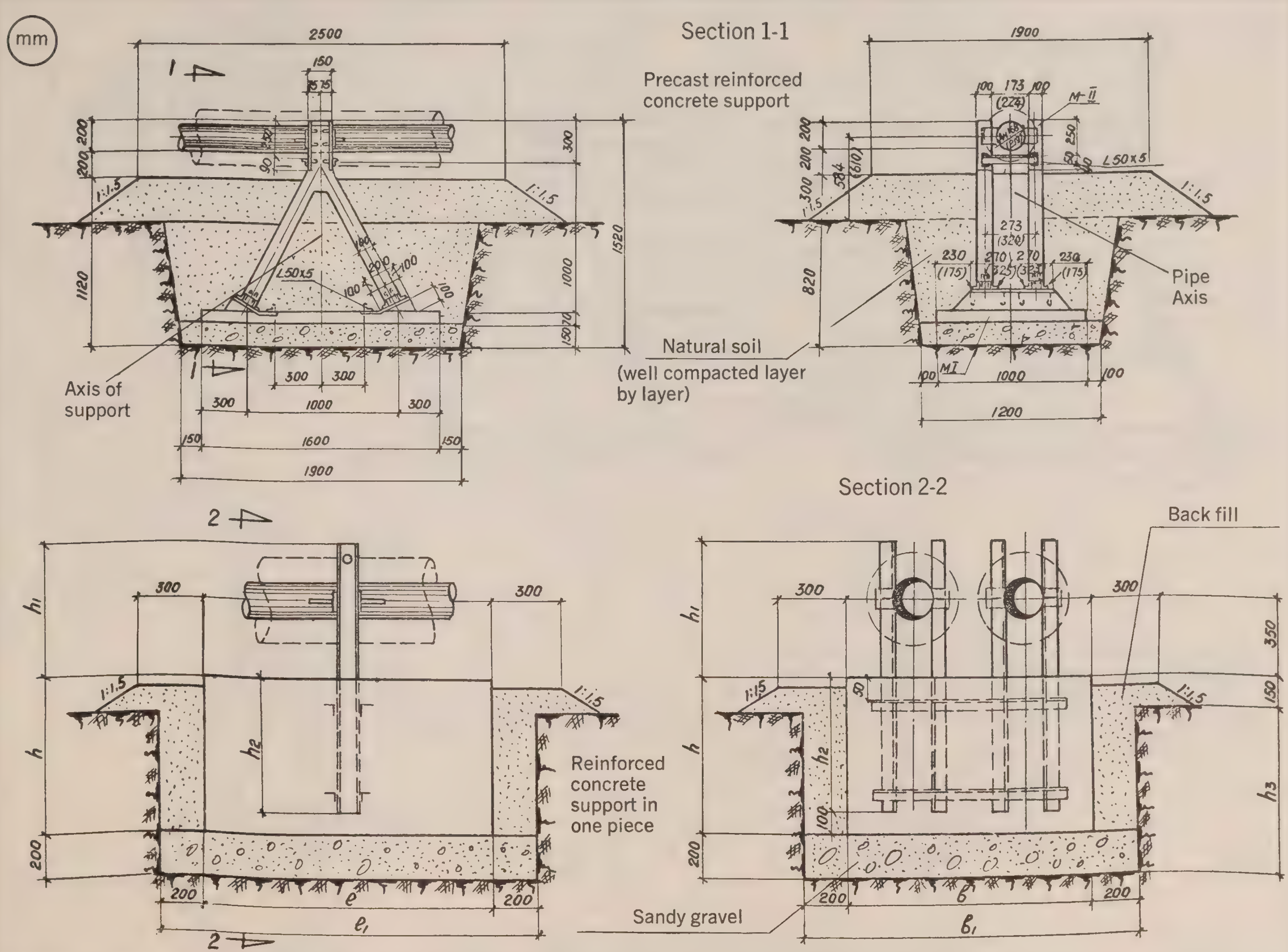
Detail 1.



Support under an expansion joint

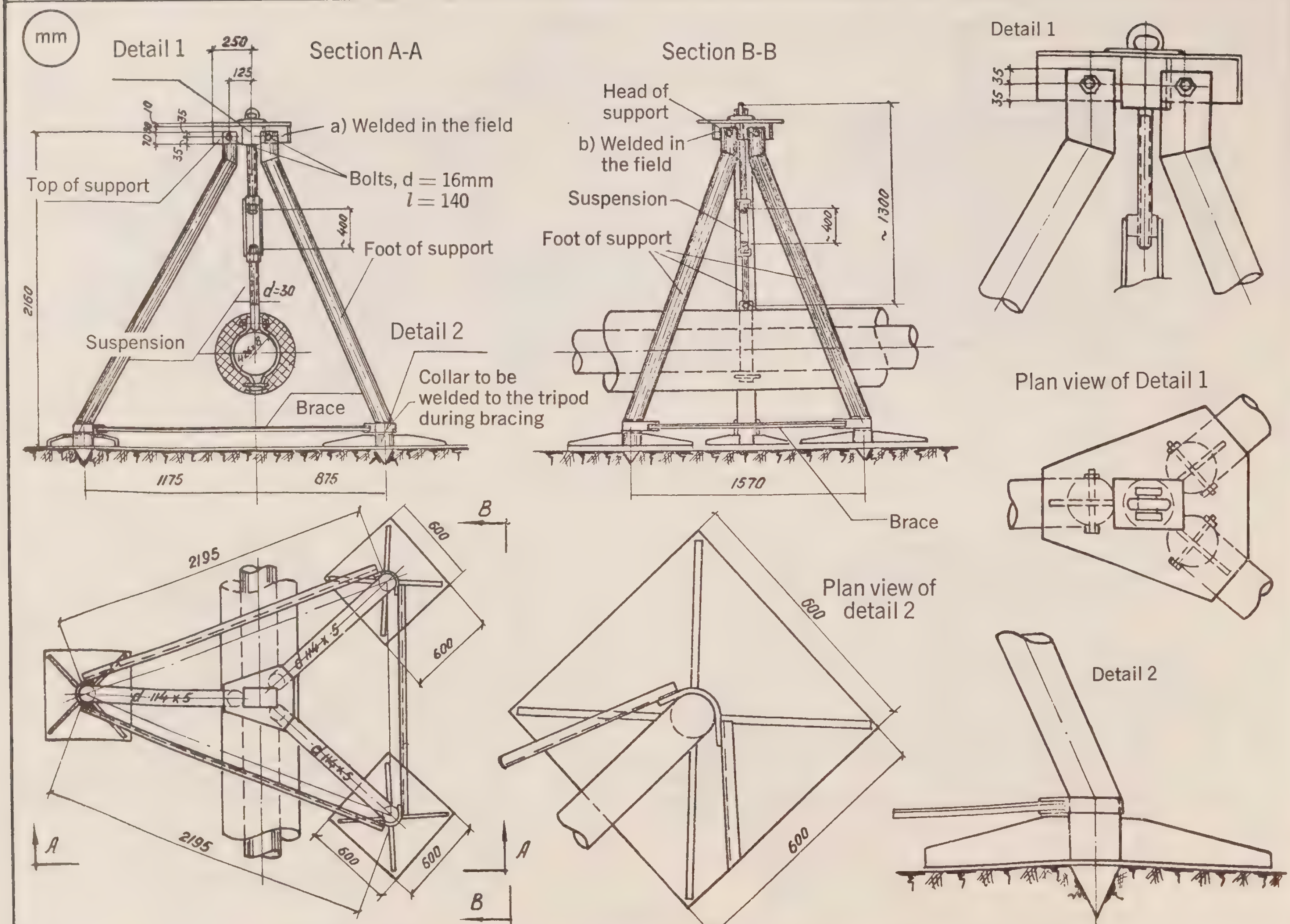




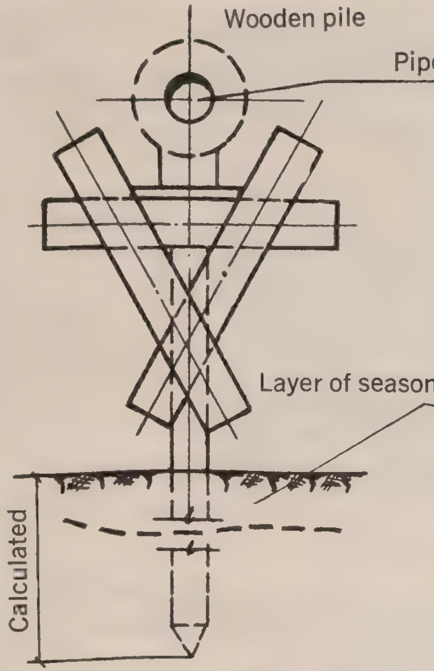

mm
Section 1-1
Precast reinforced concrete support
Natural soil
(well compacted layer by layer)
Axis of support
Pipe Axis
L50x5
Section 2-2
Back fill
Reinforced concrete support in one piece
Sandy gravel

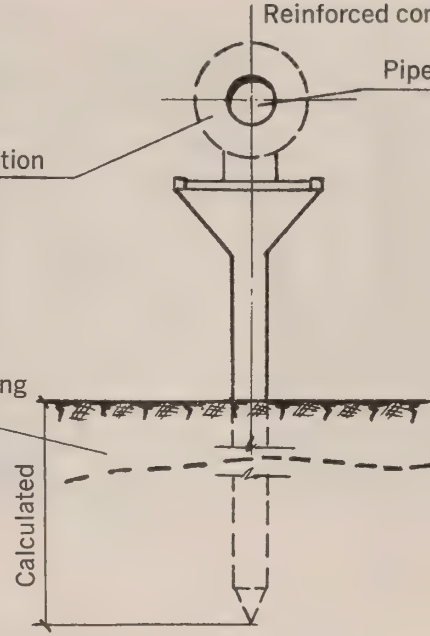
Support for a Suspended Pipeline (Noril'sk)

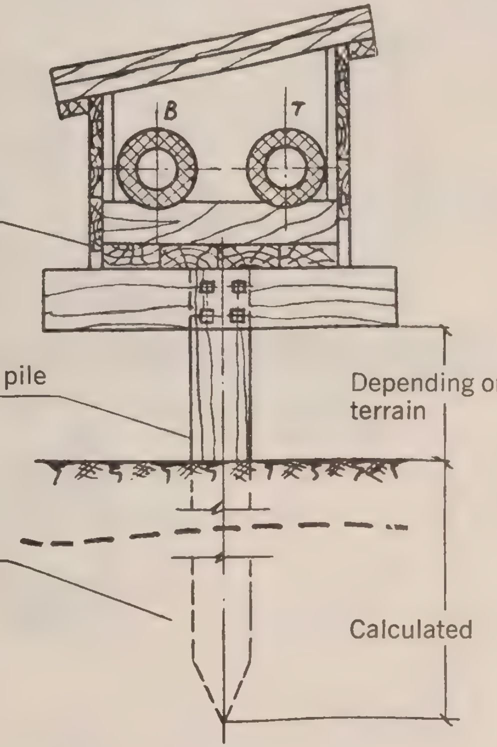
III – 6

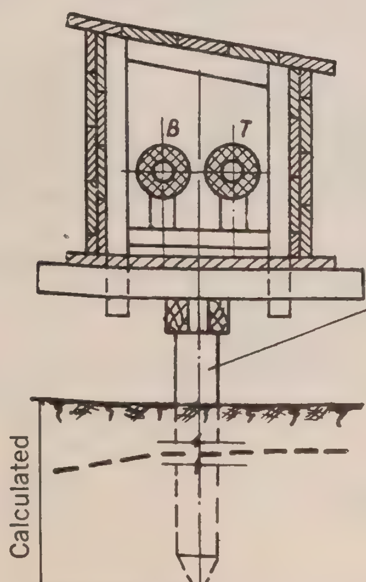


Pipeline is installed in a zig-zag pattern without anchors and expansion joints

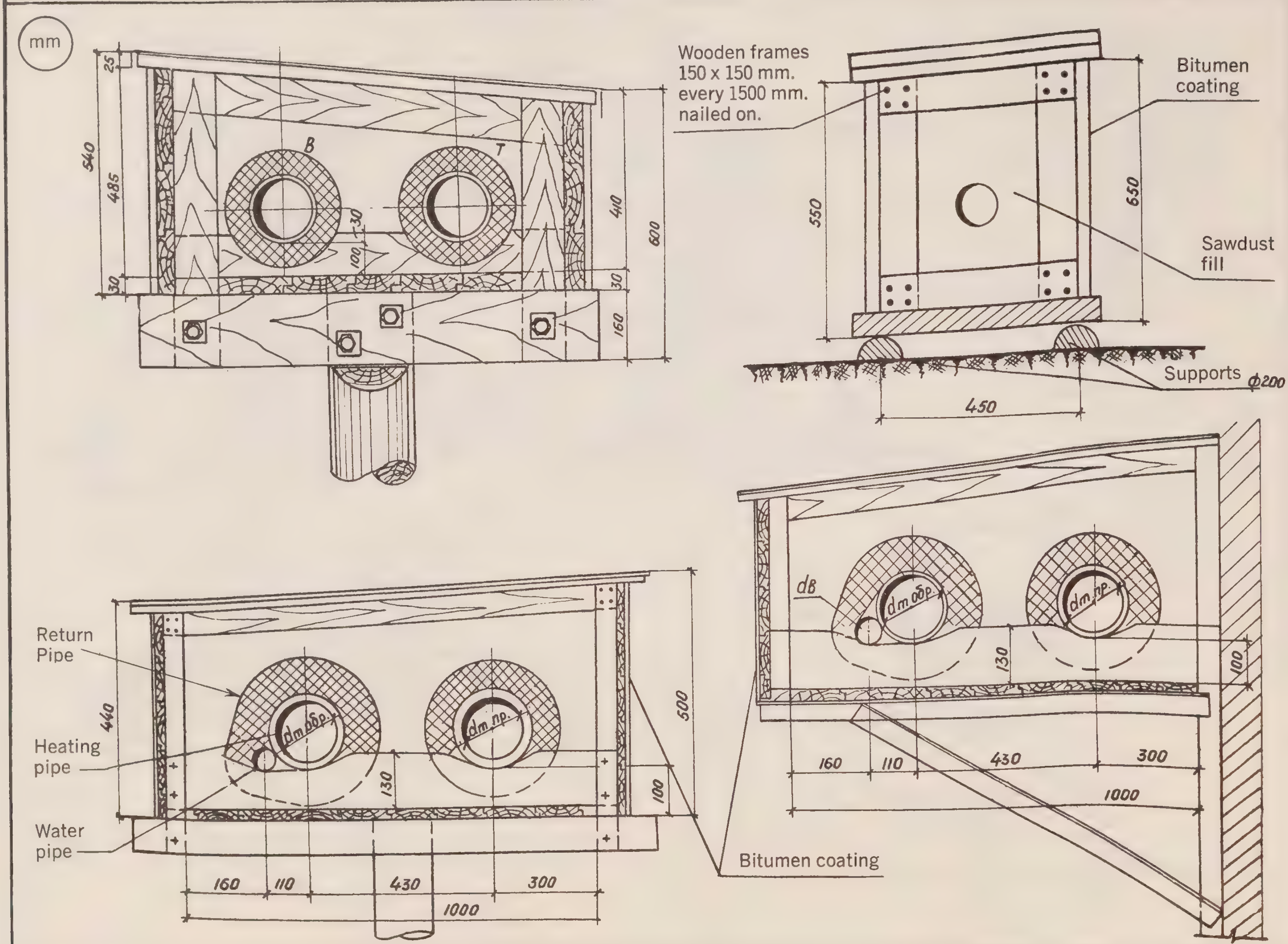








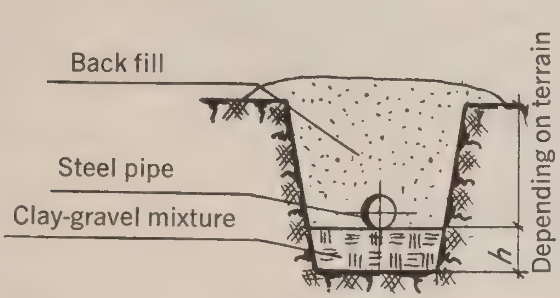
The depth of installation of pile (H) is found from the condition of equilibrium between the heaving forces in the seasonally thawed layer and the adfreezing forces of the pile to the soil in the frozen zone.

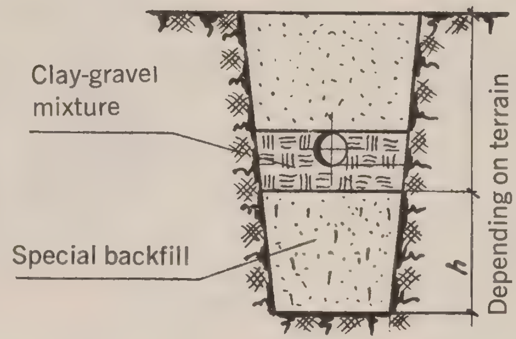

mm
25
540
485
30
B
T
30
100
410
600
30
160
Wooden frames
150 x 150 mm.
every 1500 mm.
nailed on.
Bitumen
coating
550
650
Sawdust
fill
Supports
ϕ200
450
Return
Pipe
Heating
pipe
Water
pipe
440
dm обр.
dm пр.
130
100
500
160
110
430
300
1000
Bitumen coating
dв
dm обр.
dm пр.
130
100
160
110
430
300
1000

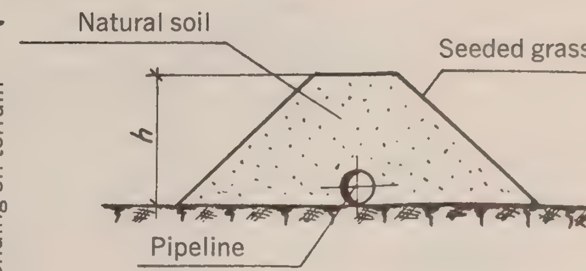
Installation of pipes underground and in embankments

III – 9

mm

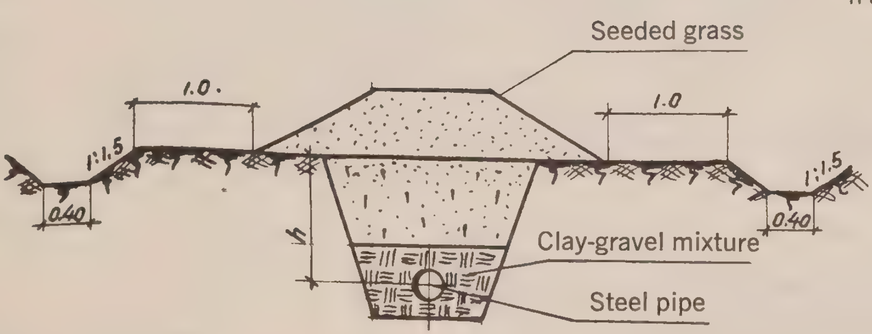


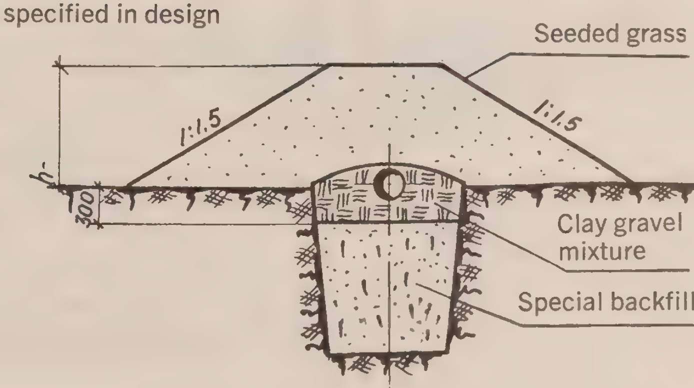




h determined by calculation

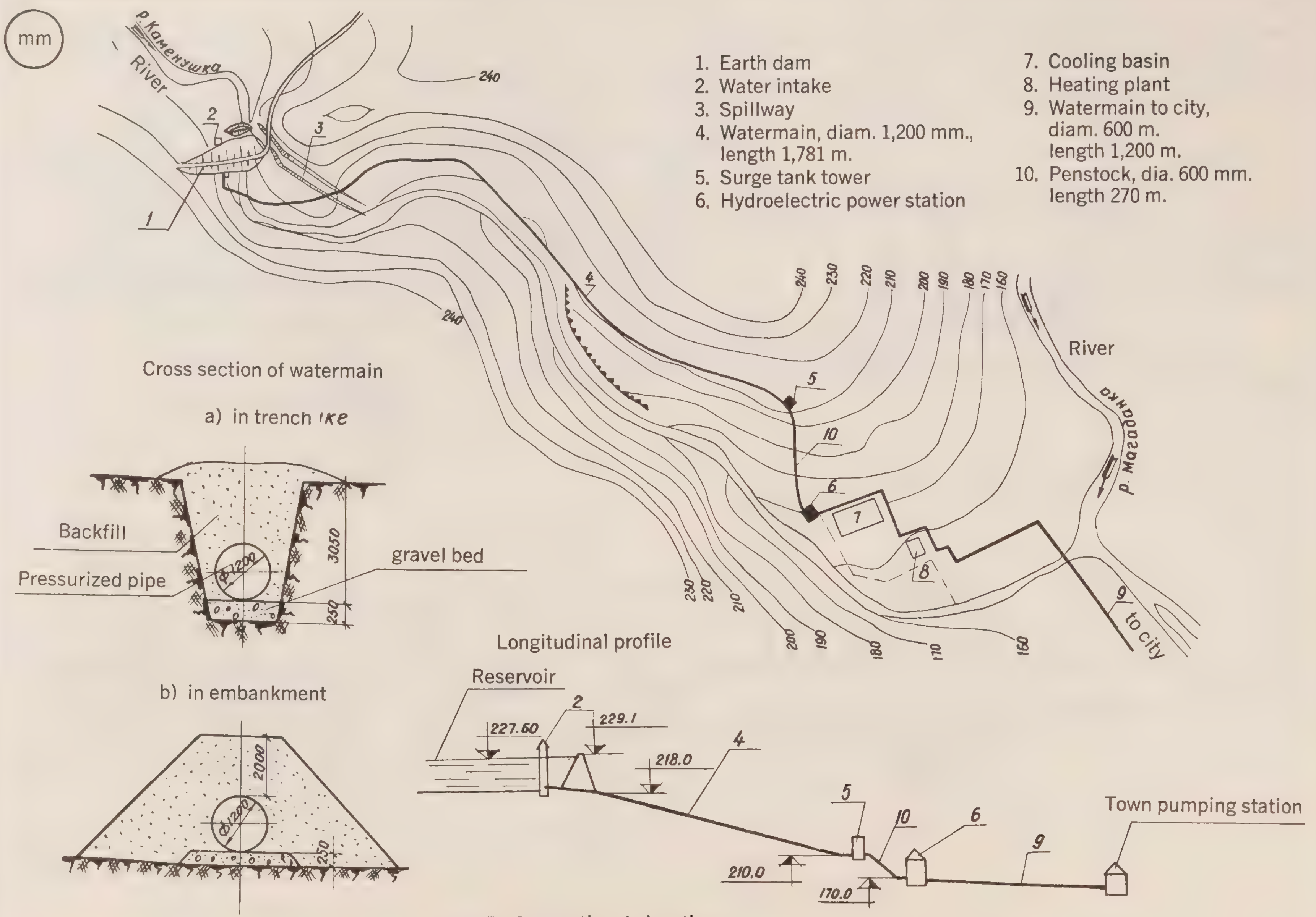
h as specified in design





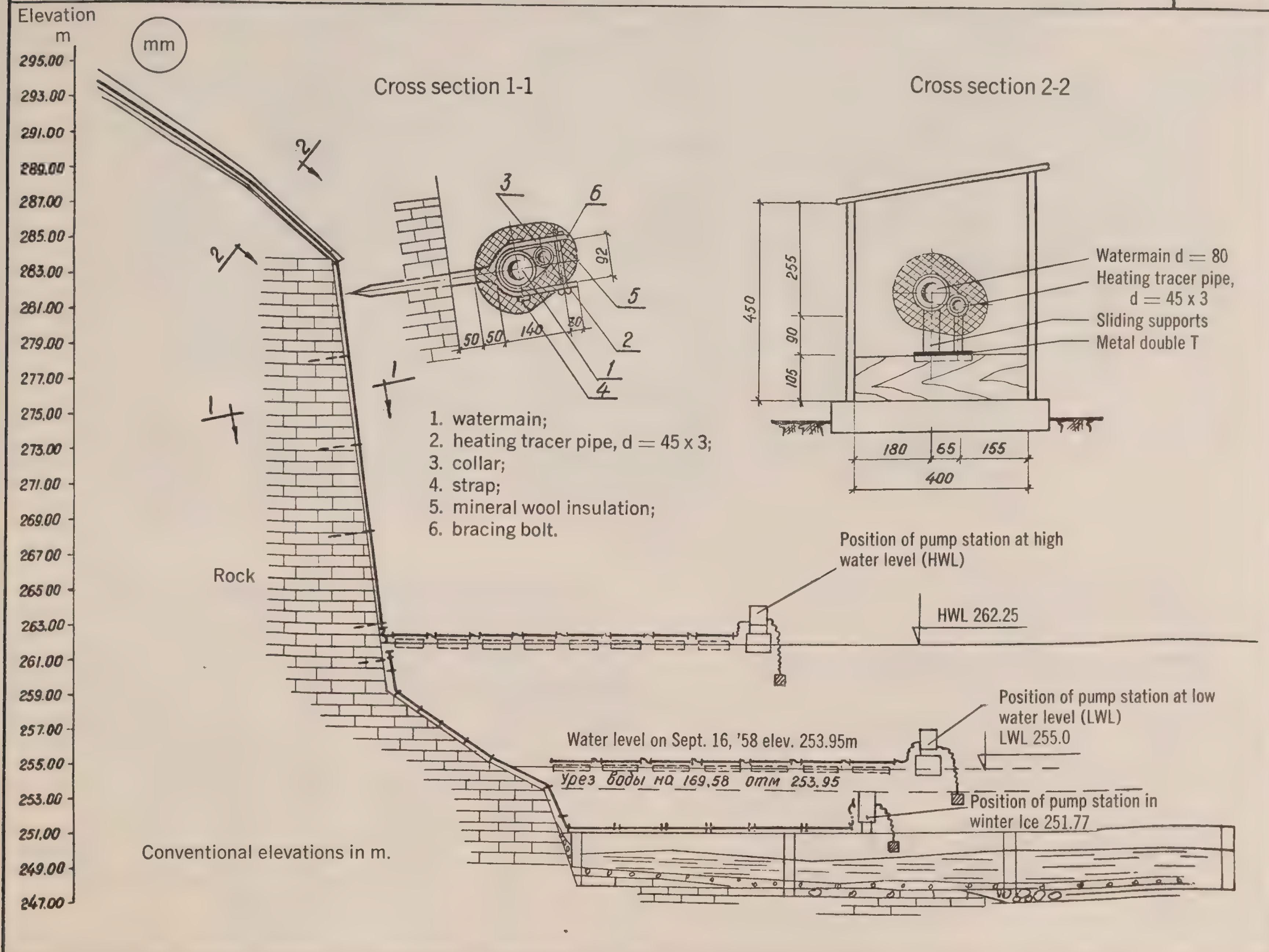
Water Supply System in Magadan
Plan View, Layout and Cross-sections of Water-mains

III – 10

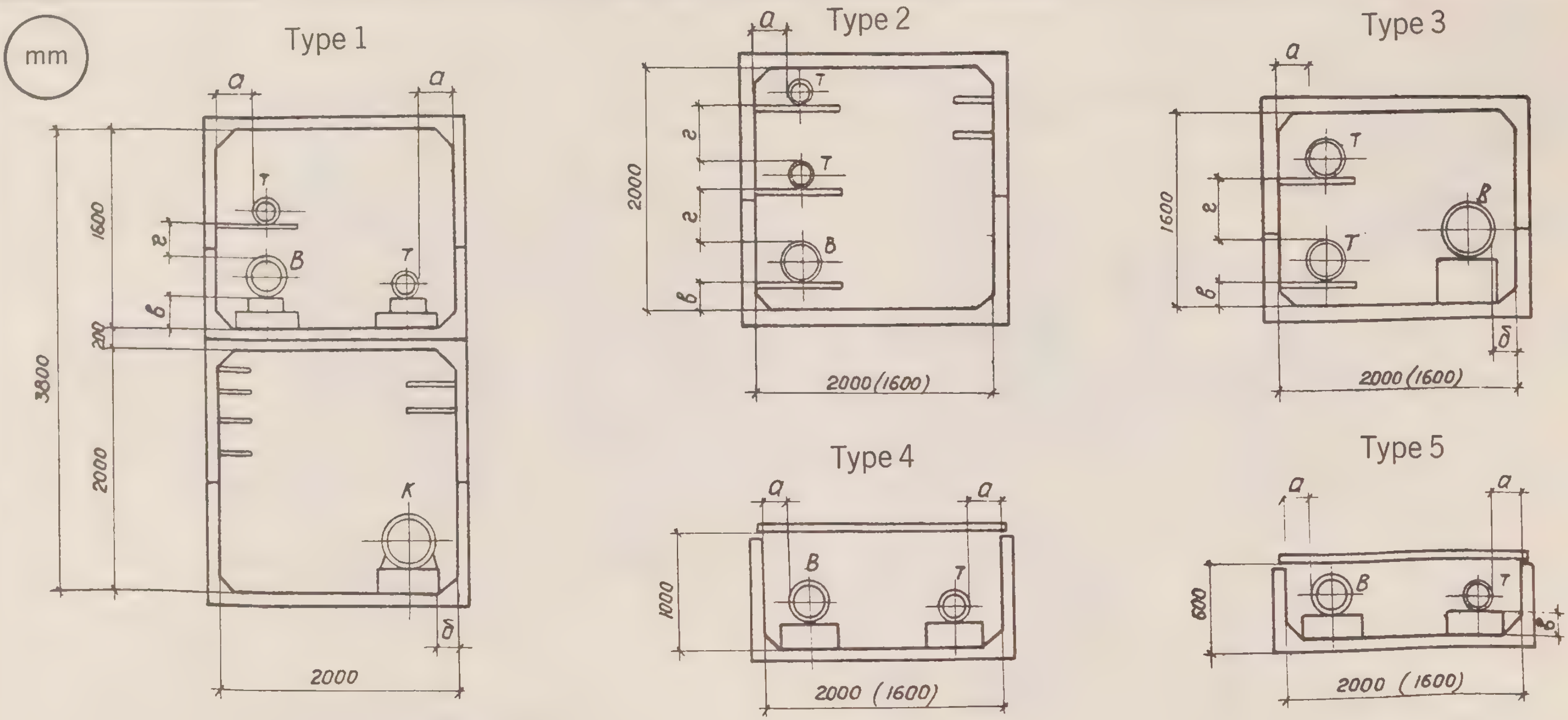


N.B. Conventional elevations
Unfrozen soils.

Water supply line in Pokrovsk, Longitudinal and Cross-sections	III — 11



mm



a. distance from the surface of pipe to the wall of conduit:
160 mm — at ø up to 150 mm;
270 mm — at ø from 200 to 300 mm;
400 mm — at ø over 300 mm;

b. distance from the surface of sewer pipe to the wall of conduit:
200 mm — at ø from 150 to 350 mm;
300 mm — at ø over 350 mm;

c. distance from the floor of conduit to the pipe wall:
250 mm — at ø from 100 to 400 mm;
300 mm — at ø from 450 to 600 mm;
B — watermain, K — sewer pipe;
T — heating pipe

d. vertical distance between pipe walls:
250 mm — at ø from 100 to 200 mm;
300 mm — at ø from 250 to 350 mm;
350 mm — at ø from 400 to 500 mm.

Volume of reinforced concrete per linear meter of conduit

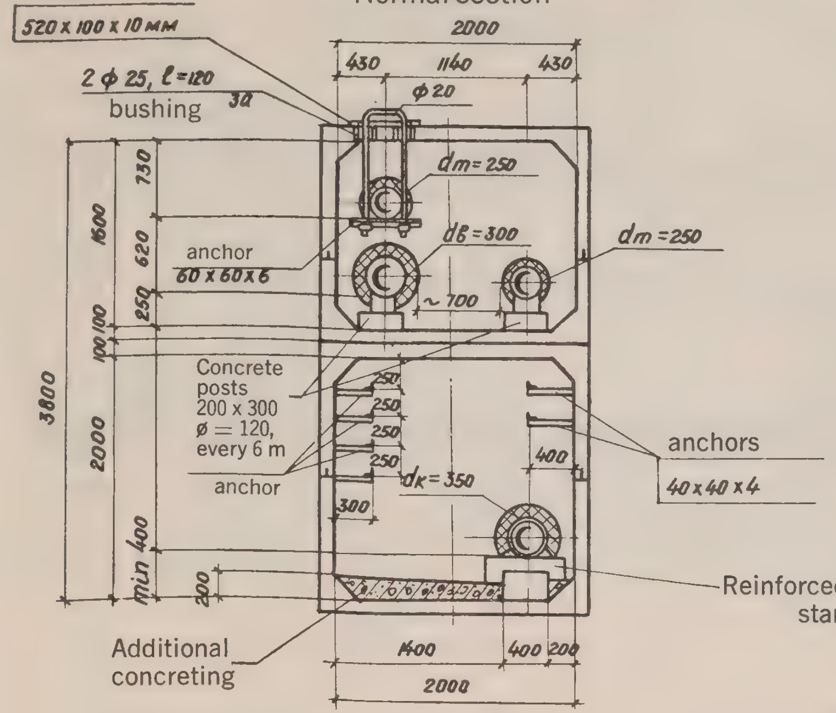
Type of conduit	clear cross-sectional area		Volume of concrete, m^3	Remarks
	width mm	height mm		
1	2000	3800	1,782	Upper level 1.6m Lower level 2m
2	2000	2000	0,934	
	1600		0,746	
3	2000	1600	0,850	
	1600		0,670	
4	2000	1000	0,778	Including removable cover of beams measuring 120 x 150 mm.
	1600		0,629	
5	2000	600	0,697	
	1600		0,564	

Two-level reinforced concrete conduit (Noril'sk)

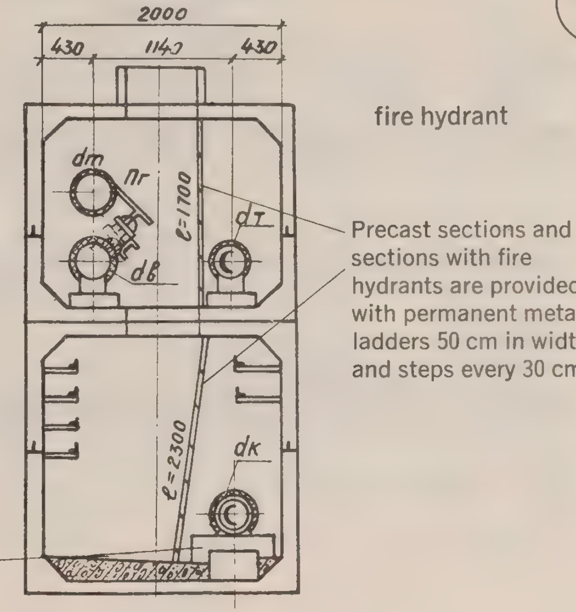
III – 13

mm

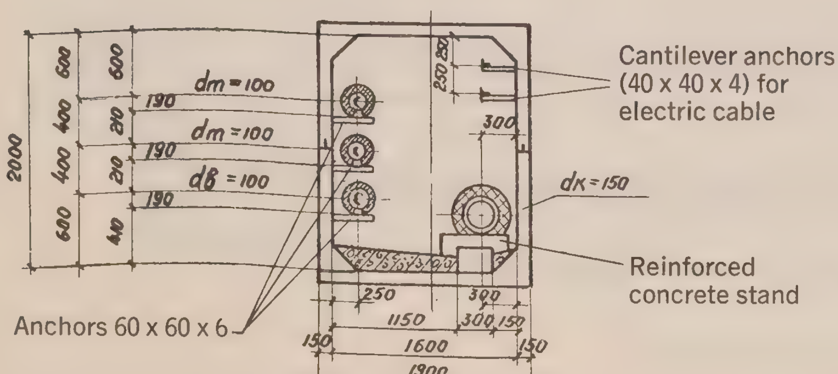
Normal section



Section with fire hydrant



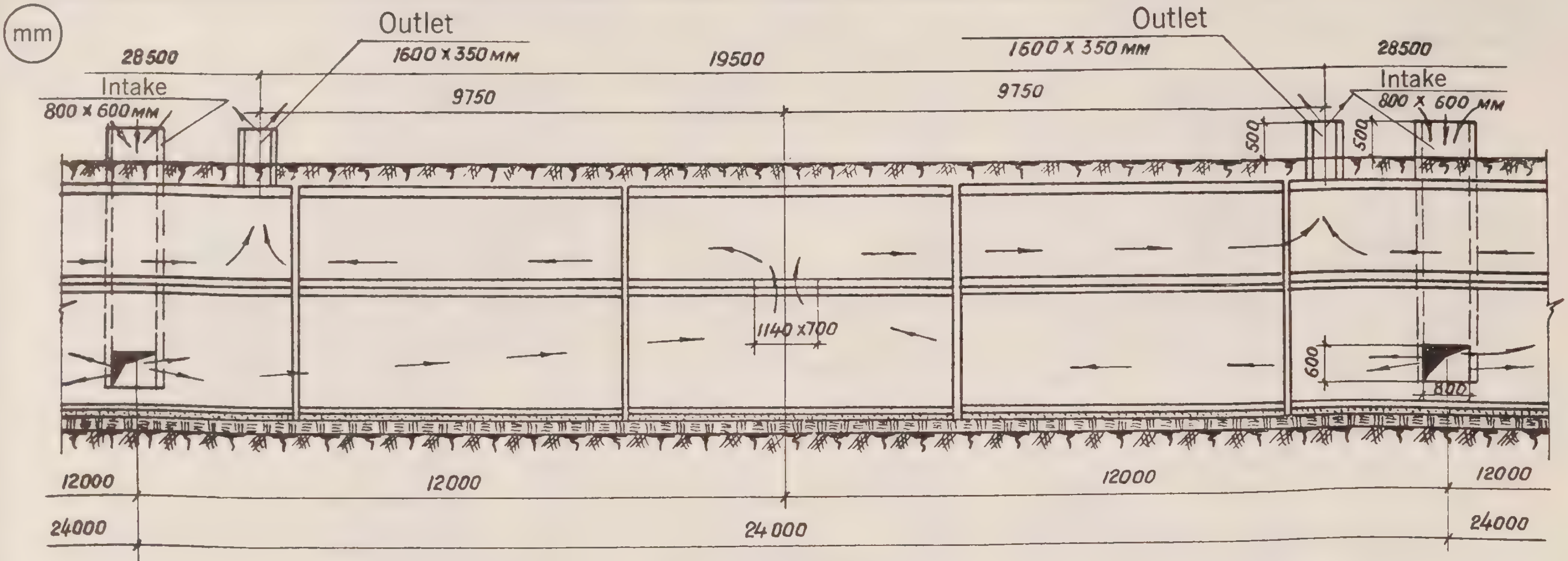
House connections in single level conduits



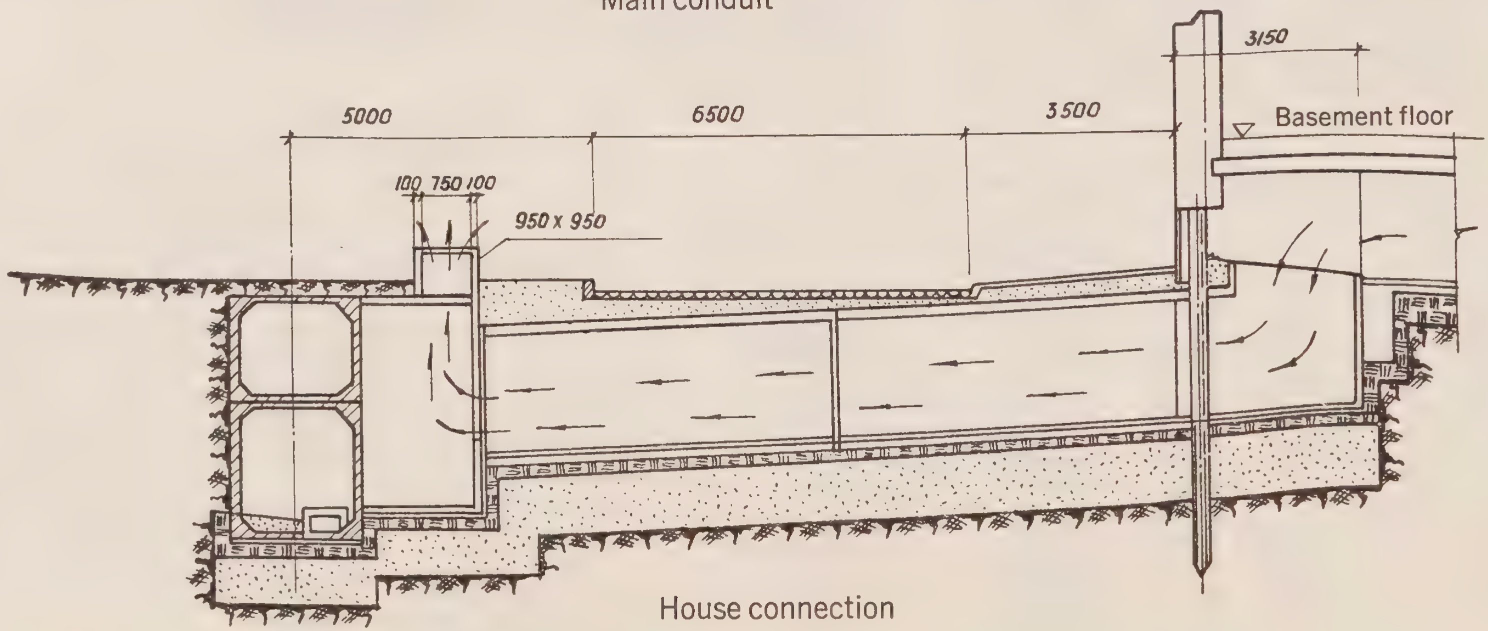
Volume of work per linear m of conduit (in cu. m)

No	Item	Volume per linear m of conduit	Volume per linear m of house connection
1.	Reinforced concrete	1,782	0,746
2	Excavation	19,58	7,07
3	Special backfill	1,88	1,76
4	Placement of clay-gravel mixture	0,63	0,6
5	Additional concreting	0,24	0,24
6	Backfill	12,78	2,79

Ventilation of conduit and house connection



Main conduit



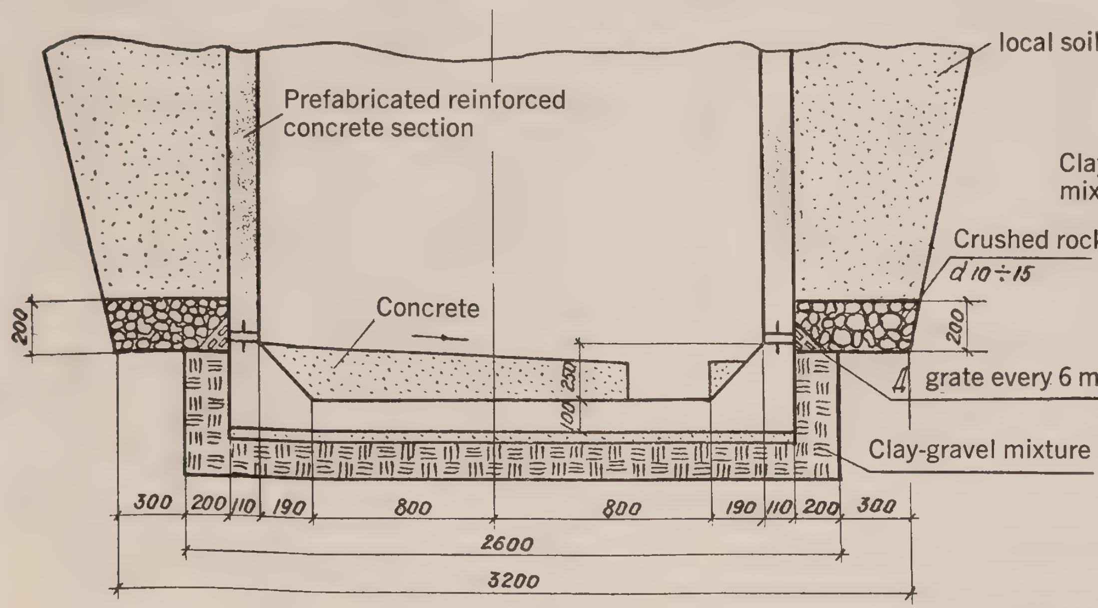
House connection

Drainage and foundations of conduits (Noril'sk)

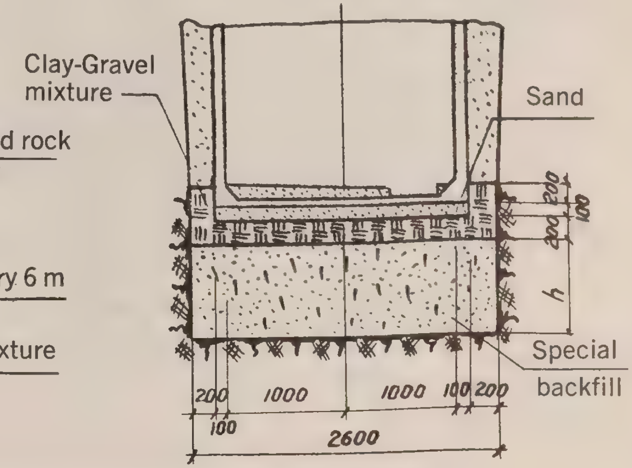
III – 15

mm

Foundation drainage



Foundation on soils subject to settlement

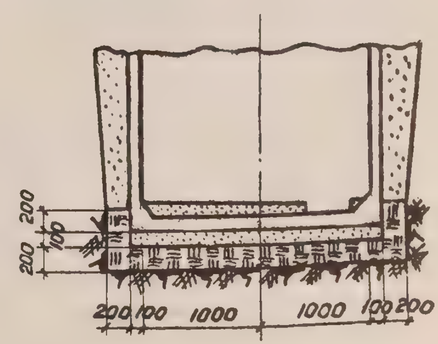


Drainage may be in the form of pipes. The pipe is closed with a metal grate and covered with a layer of filtering material.

Water in the trough on the bottom of the conduit runs off down the slope of the conduit.

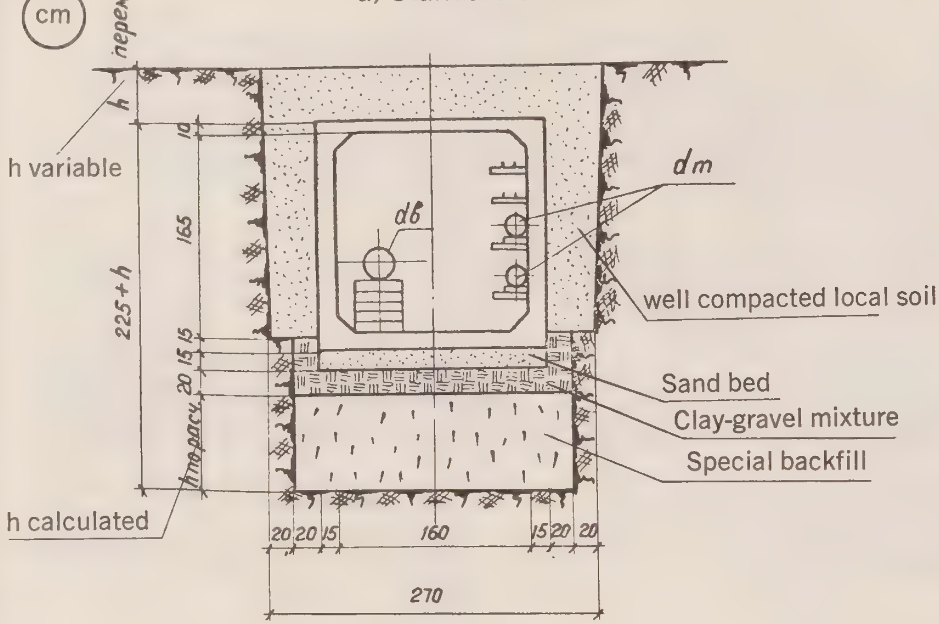
Foundation soils which settle by more than 5 cm per linear meter of depth are replaced by soil, not subject to settlement, to a depth of 0.8 m (depth of thawing below the conduit).

Foundations on soils not subject to settlement

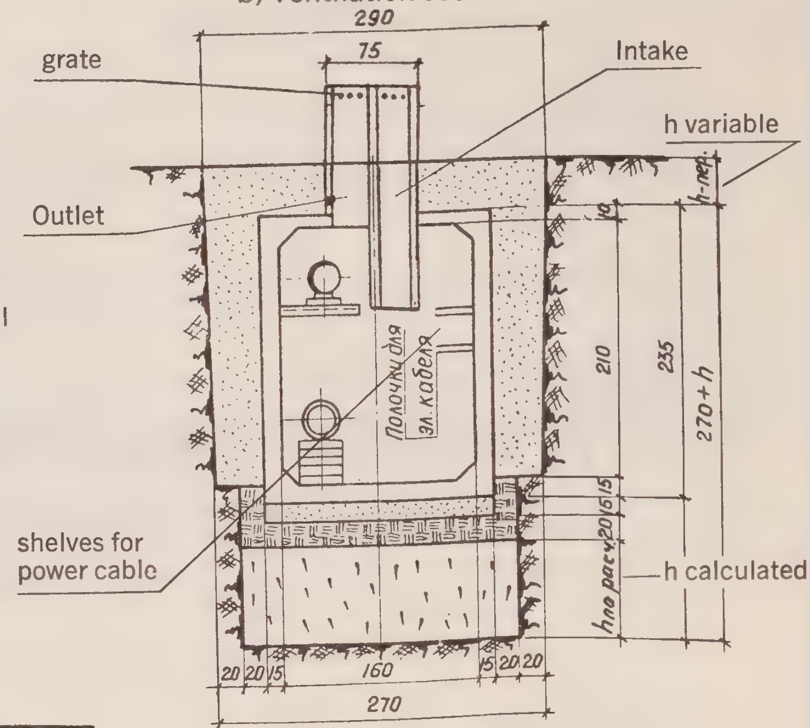


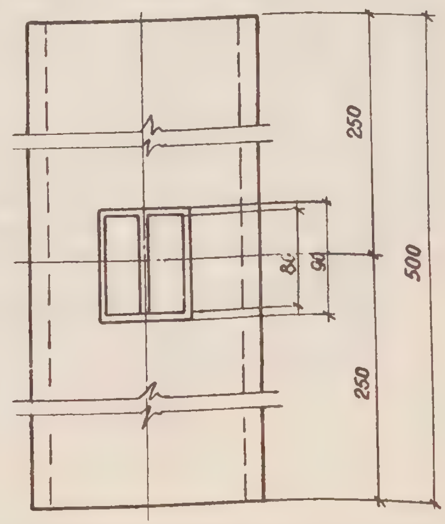
One-level, reinforced concrete, accessible conduit (Noril'sk)	III – 16

a) Standard section



b) Ventilation section





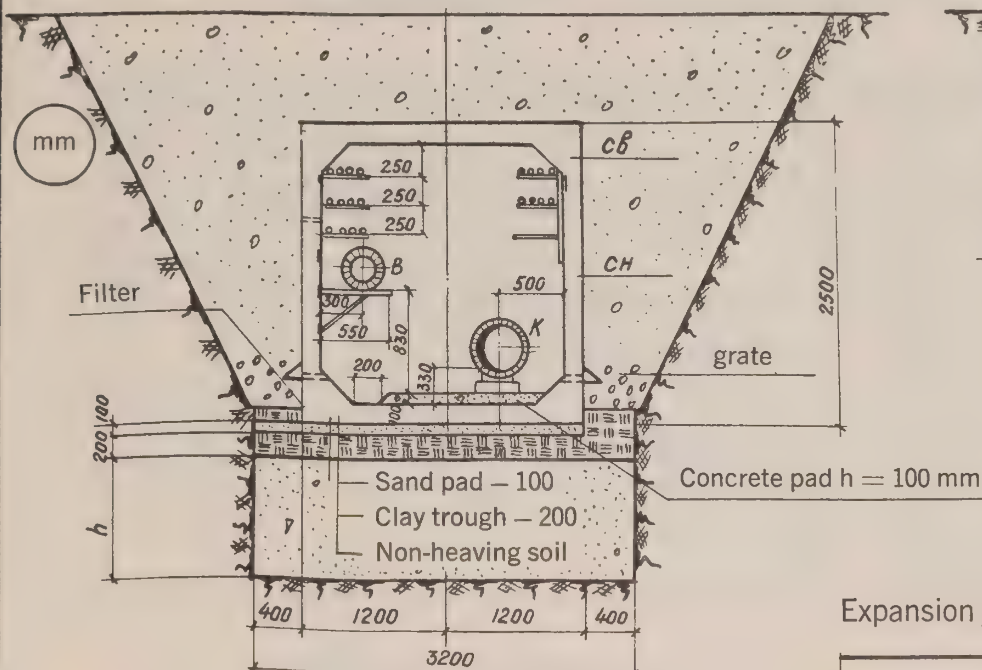
Volume of work per linear m of conduit (in cu. m)

No.	Item	Volume
1	Excavation	10,2
2	Monolithic reinforced concrete, M – 300 Mrz – 200	1,27
3	Sand bed	0,24
4	Clay-gravel mixture below the conduit	0,64
5	Special backfill	1,84
6	Backfill	2,75
7	Clay-gravel pads for foundation sills installed every 50 m along the route of the conduit.	0,30

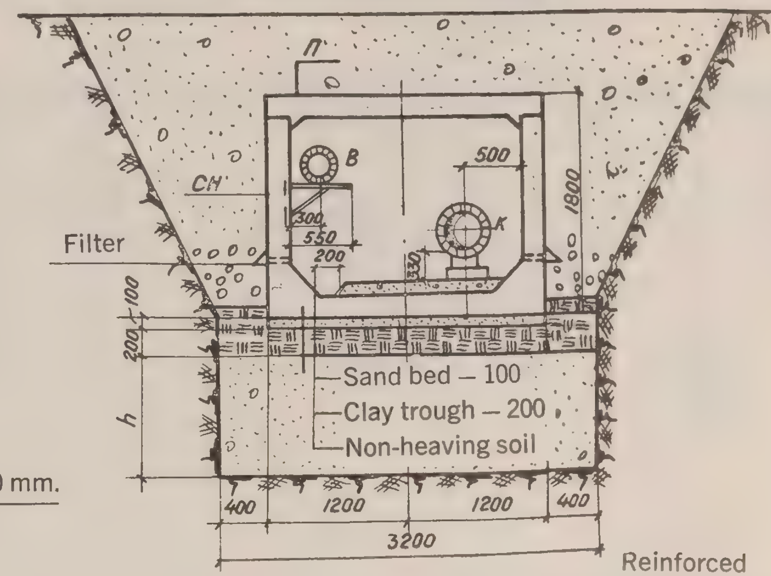
Prefabricated reinforced concrete conduits (Mirnyi)

III — 17

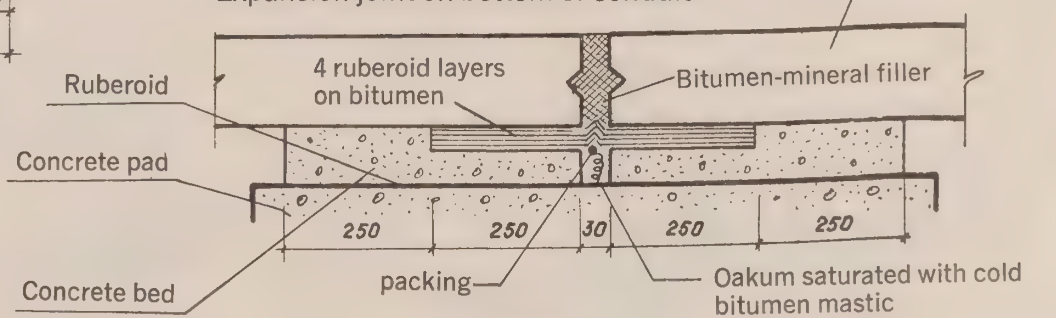
Accessible conduit



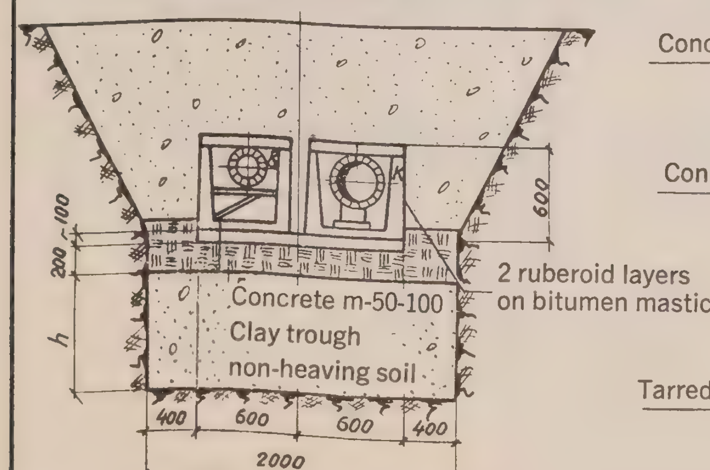
Semiaccessible conduit



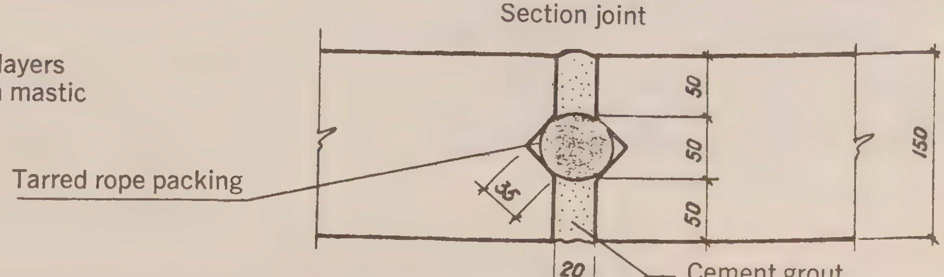
Expansion joint on bottom of conduit



Inaccessible conduit

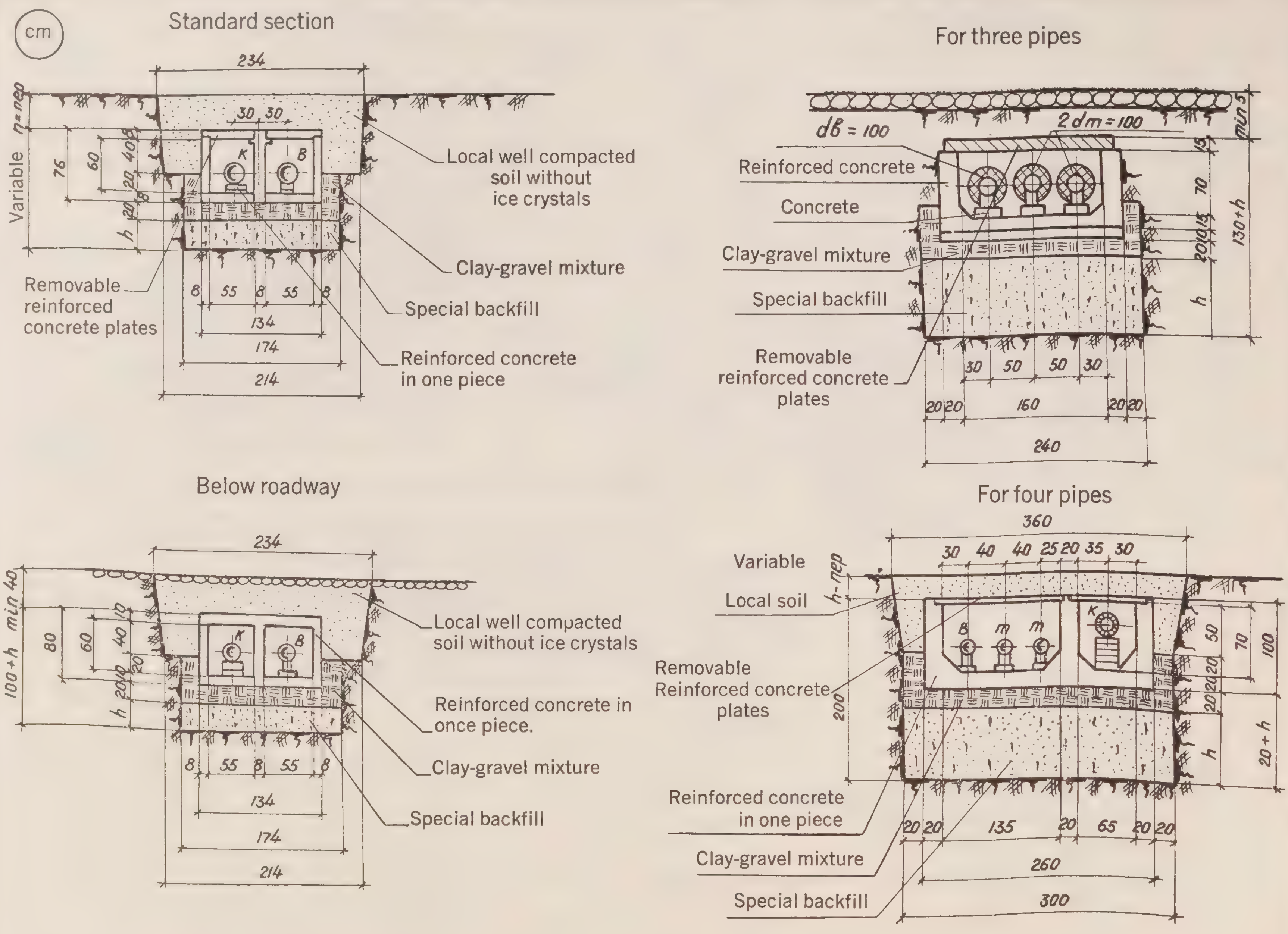


Section joint



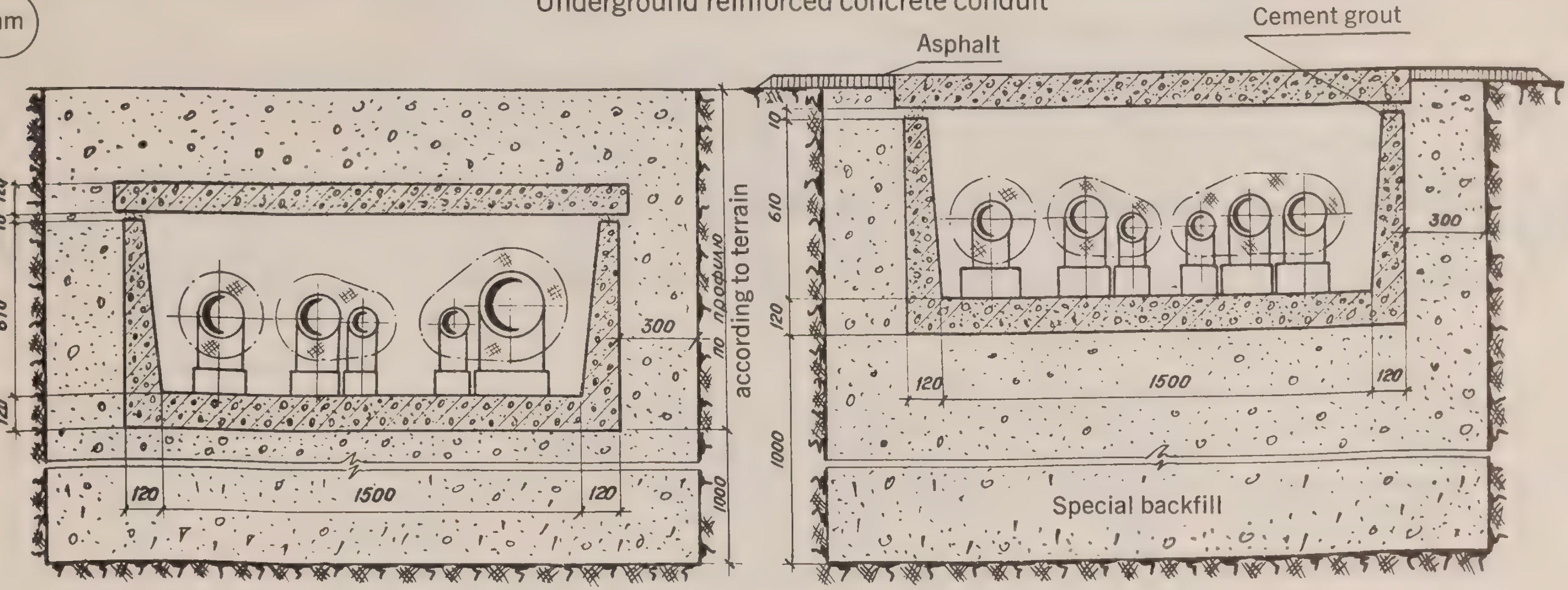
Inaccessible prefabricated reinforced concrete conduit

III – 18

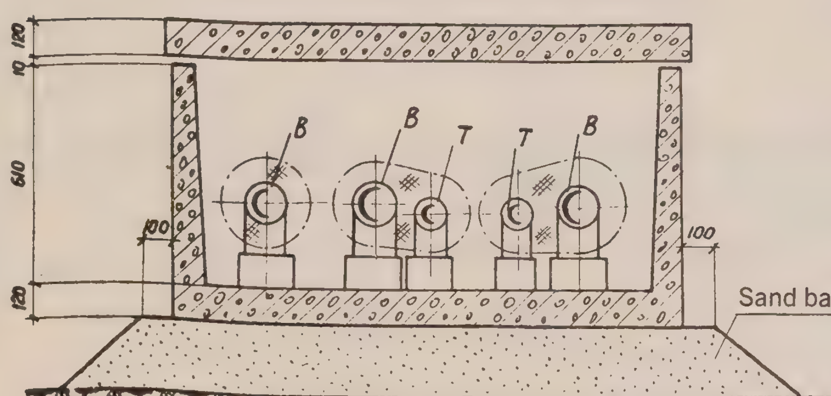


mm

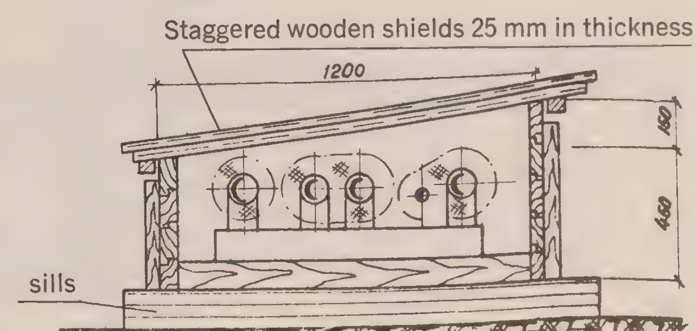
Underground reinforced concrete conduit



Reinforced concrete conduit on the surface



Wooden conduits

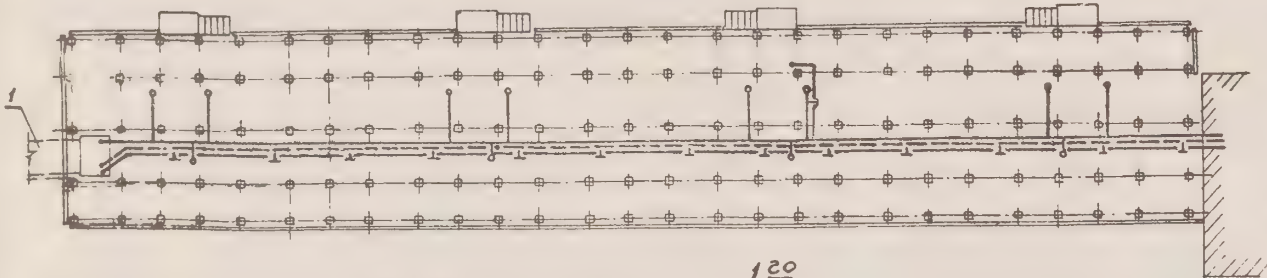


The pipelines are insulated with mineral wool, $\delta - 50$ mm. The sewage collectors are installed separately. The design has been prepared at the Research Institute of Civil Engineering in Yakutsk.

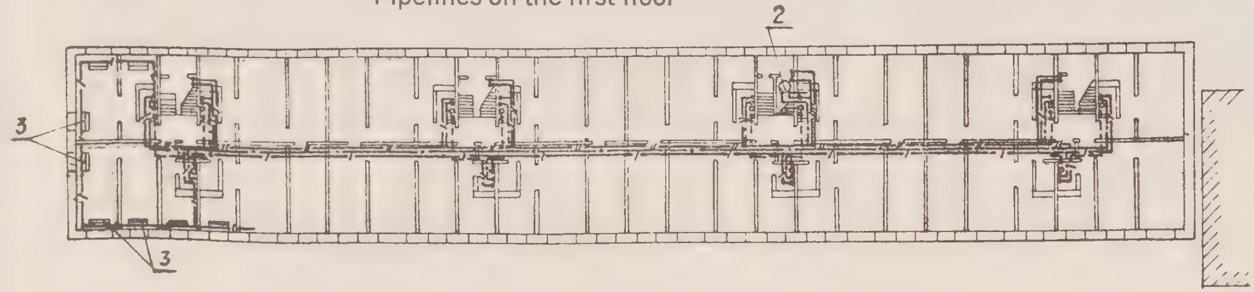
Pipelines in ventilated crawl spaces and on the first floor

III – 20

Pipelines in ventilated crawl space



Pipelines on the first floor



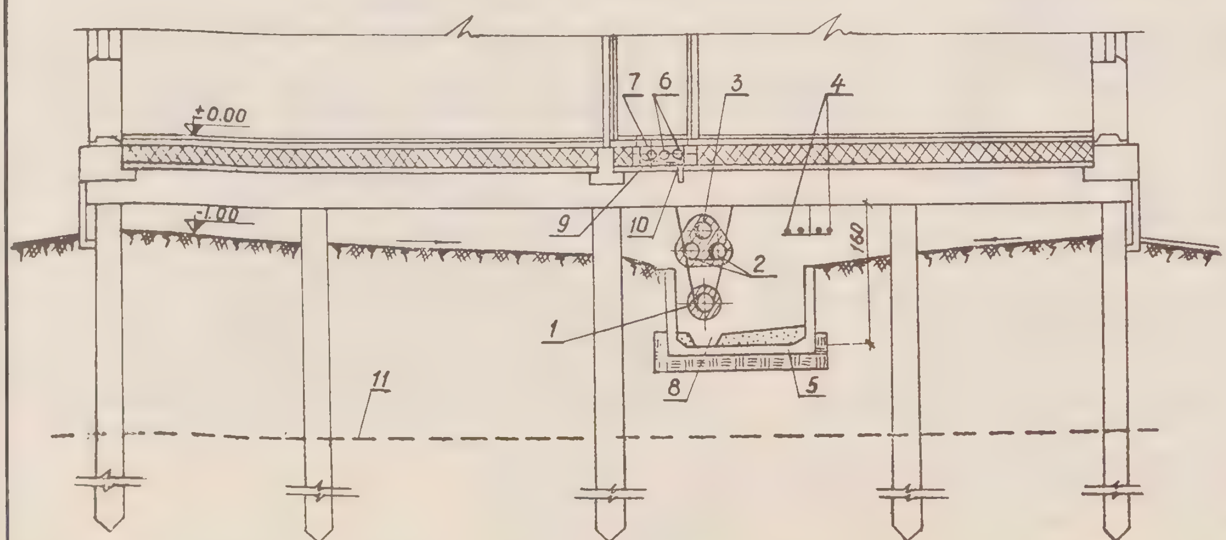
- sewers;
- cold water pipes;
- heating tracer line;
- incoming heat supply system;
- outgoing heat supply system;
- hot water pipes;

1 — pipe entrance in a conduit;

2 — furnace

3 — wall radiator

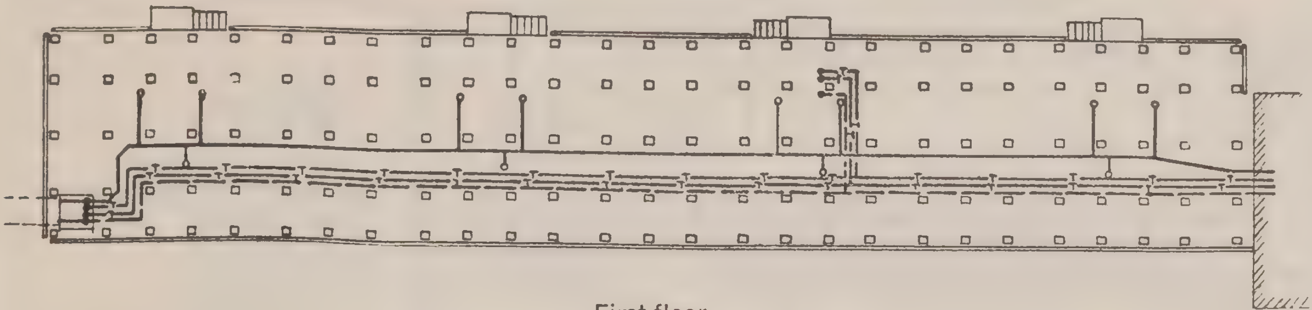
Cross section of ventilated crawl space



1. sewer pipes;
2. heating tracer lines;
3. watermain;
4. power cables;
5. conduit;
6. heat supply;
7. hot water pipes;
8. drainage trough
9. concrete base;
10. drain pipe;
11. permafrost table prior to construction

Pipelines in ventilated crawl spaces and on the first floor (Noril'sk) | III – 21

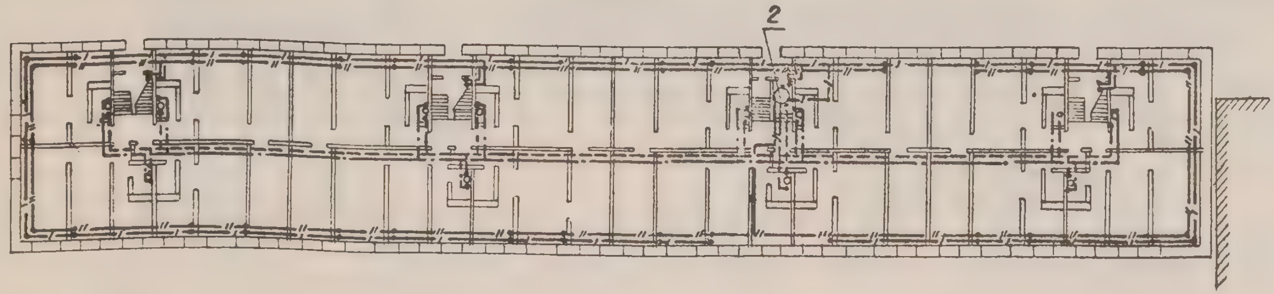
Pipelines in ventilated crawl space



- sewer;
- cold water pipe;
- heating tracer line;
- incoming heat supply system;
- outgoing heat supply system;
- hot water pipe;

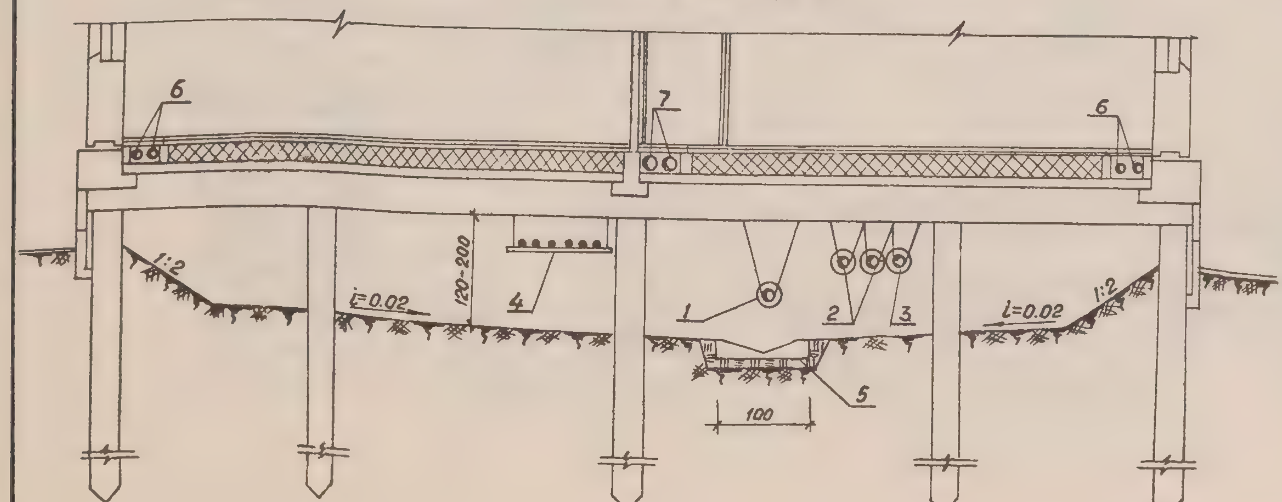
1. pipe entrance in a conduit;
2. furnace

First floor



The pipelines must be under constant observation.

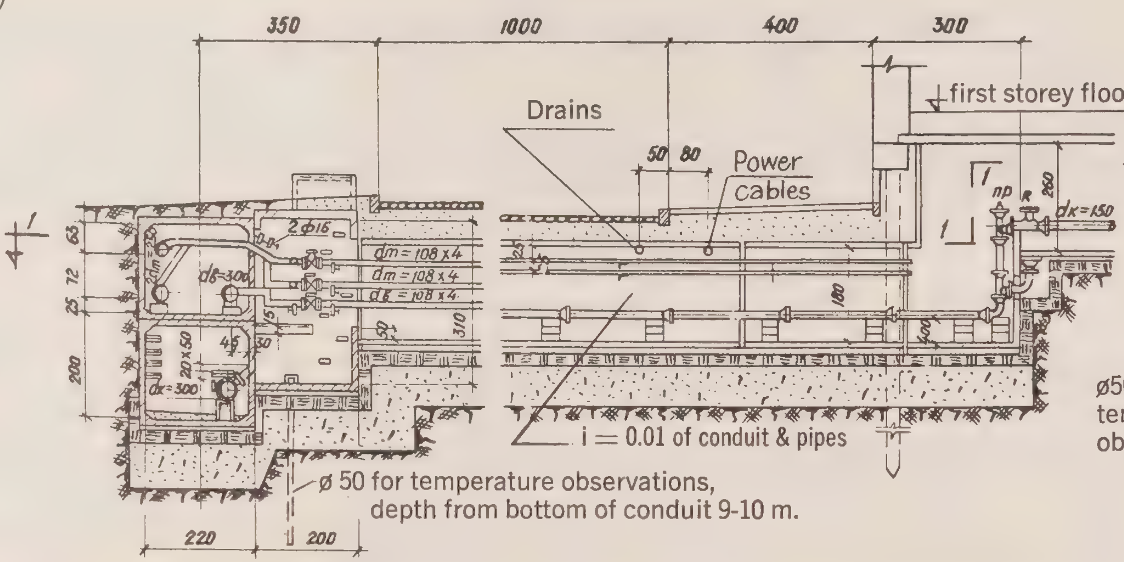
Cross section of crawl space



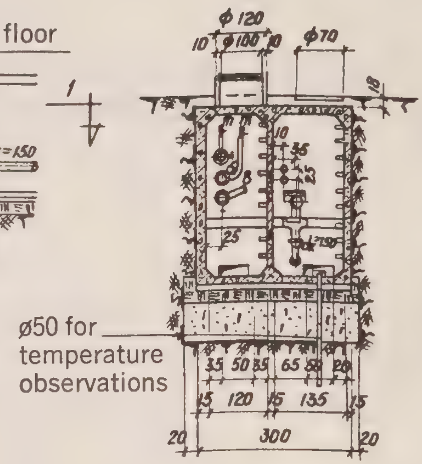
1. sewer;
2. heating tracer lines;
3. watermain;
4. power cables;
5. drainage trough;
6. heat supply system;
7. internal hot and cold water pipes.

cm

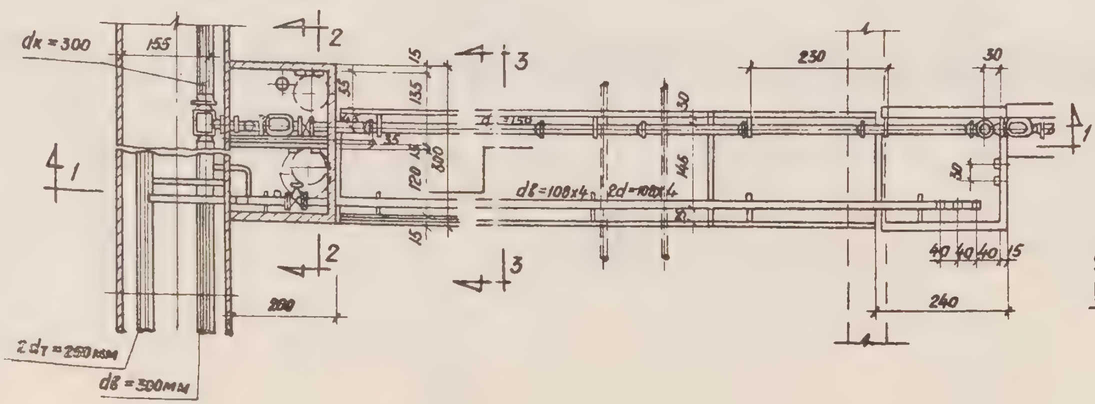
Cross section 1-1



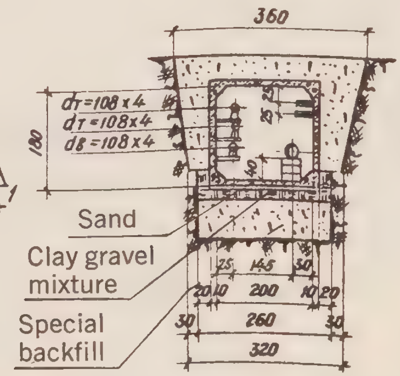
Cross section 2-2



Plan view along 1-1



Cross section 3-3

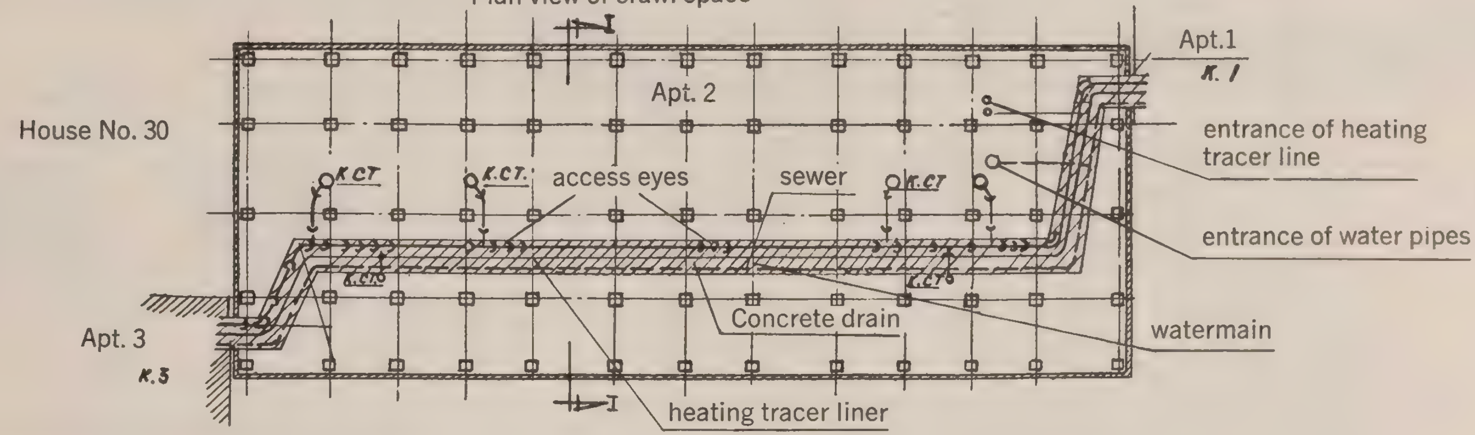


Location of pipelines in a crawl space (Noril'sk)

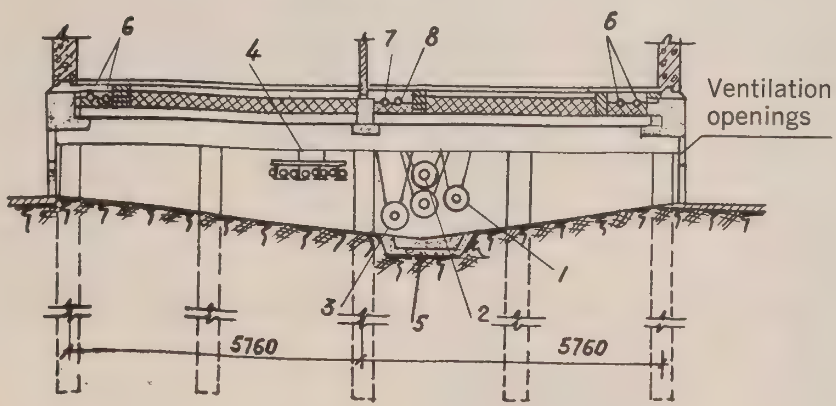
III — 23

mm

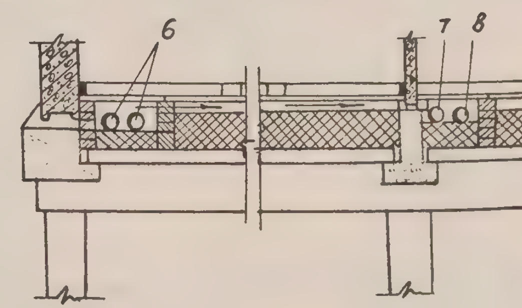
Plan view of crawl space



Cross section I-I



Floor heating system

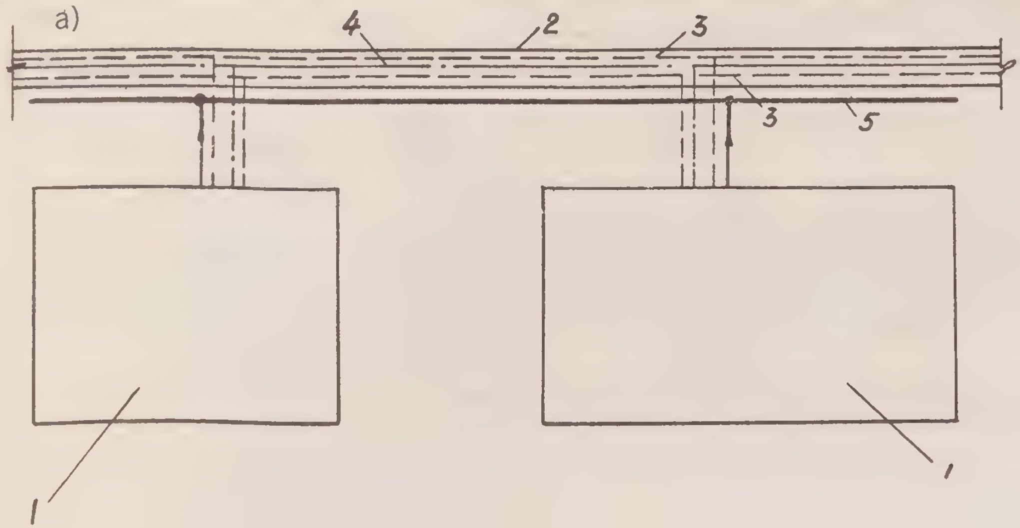


1. water main;
2. heating tracer lines;
3. sewer pipes;
4. power cables;
5. drain;
6. incoming and outgoing heat supply lines;
7. internal water supply;
8. internal hot water supply.

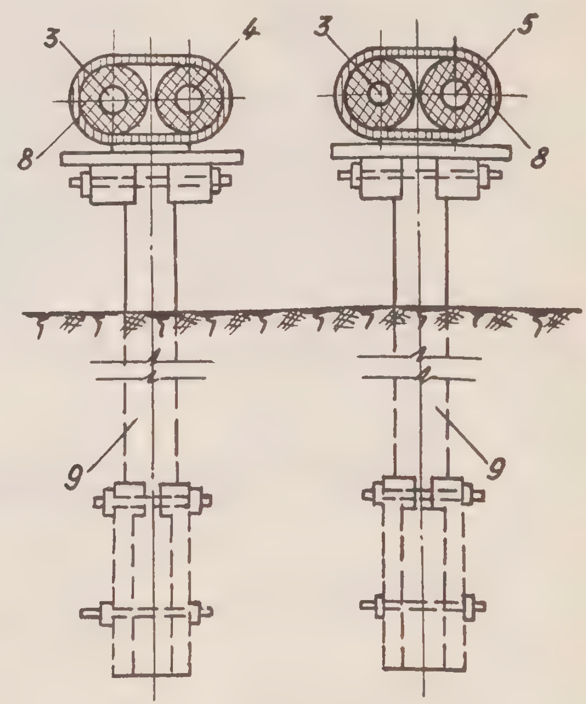
Combined house connections for buildings with ventilated crawl-spaces

III – 24

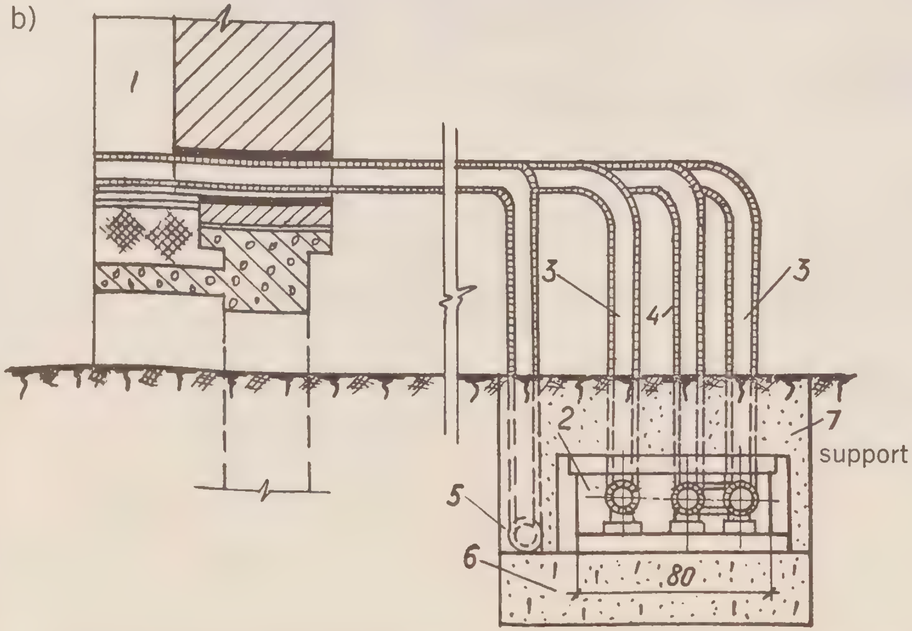
a)



Cross-section of combined house connections

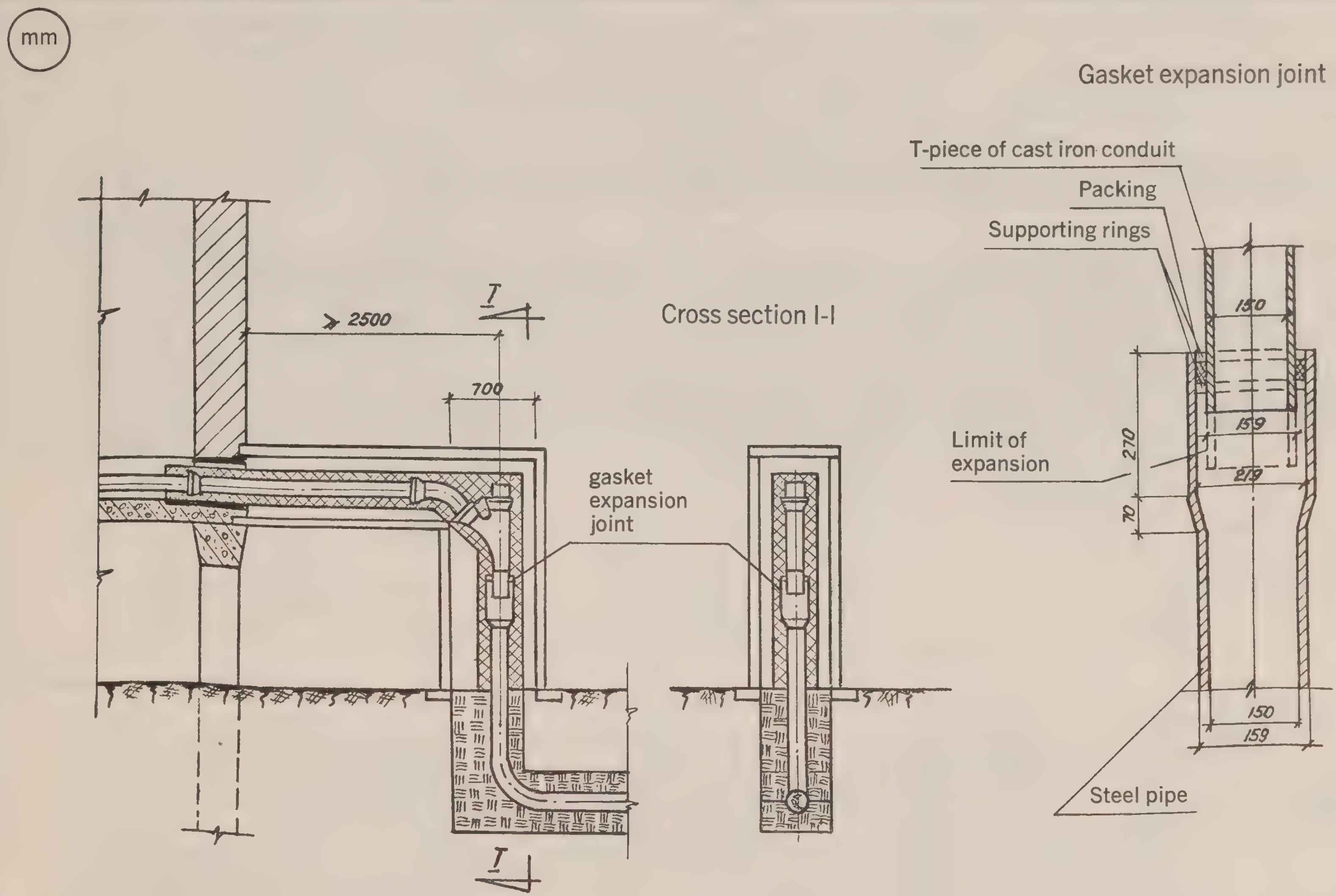


b)

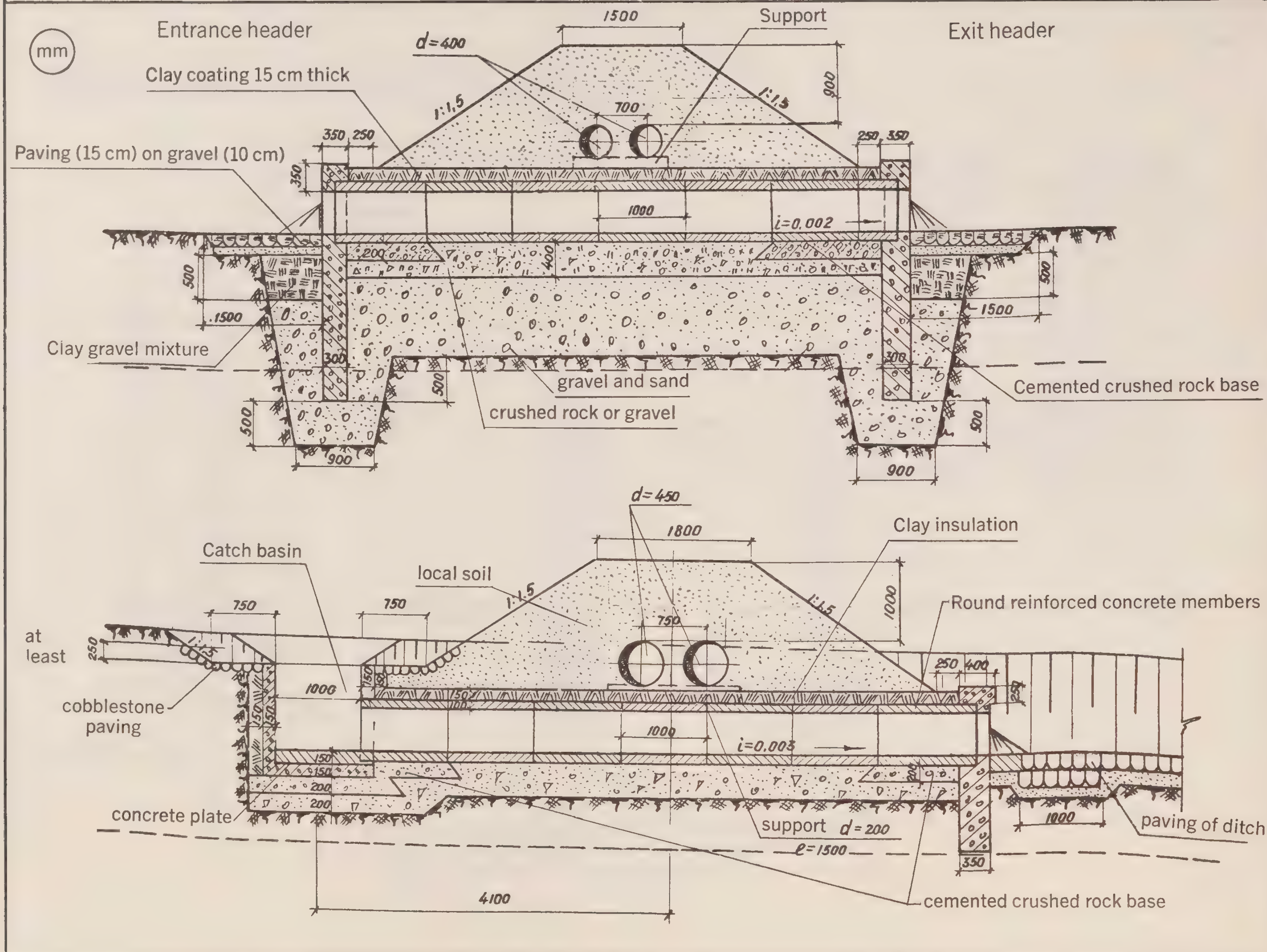


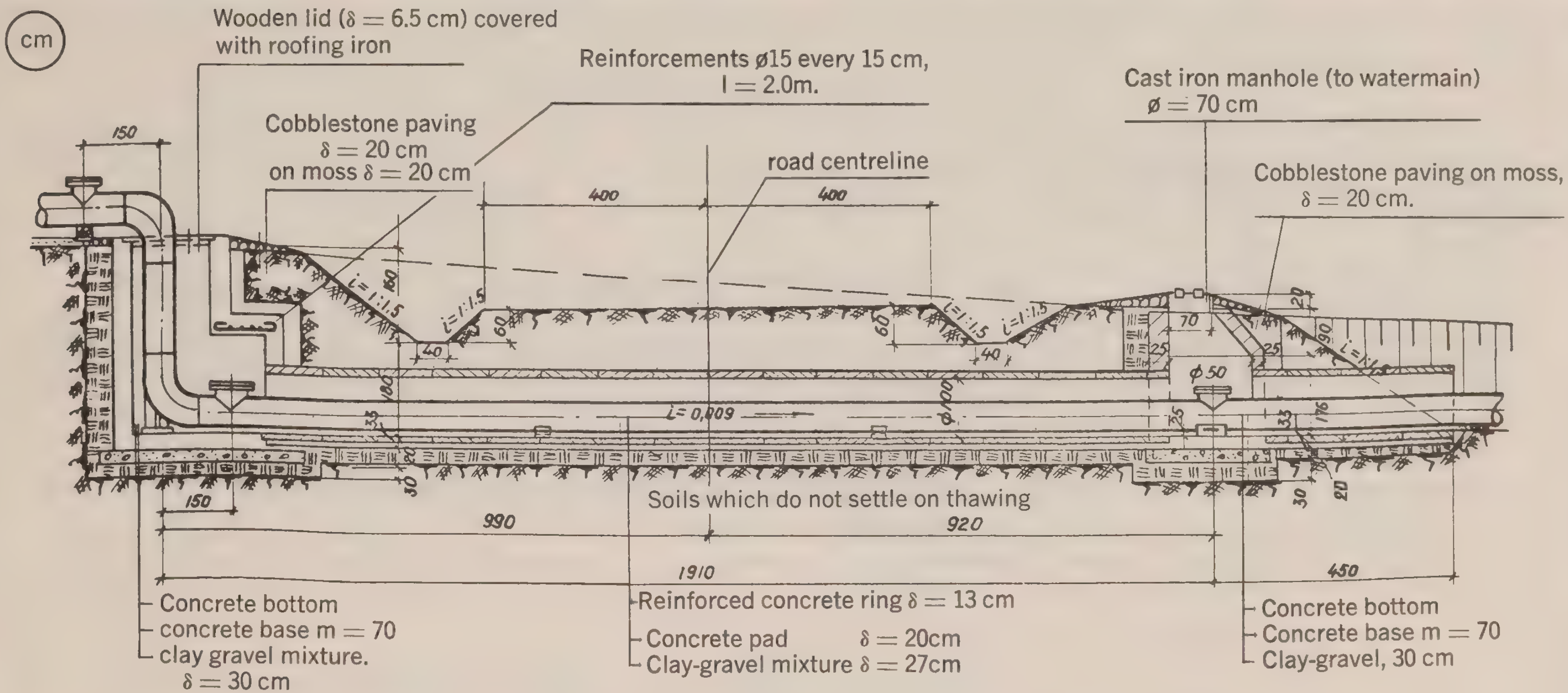
a) external systems;
b) house connections

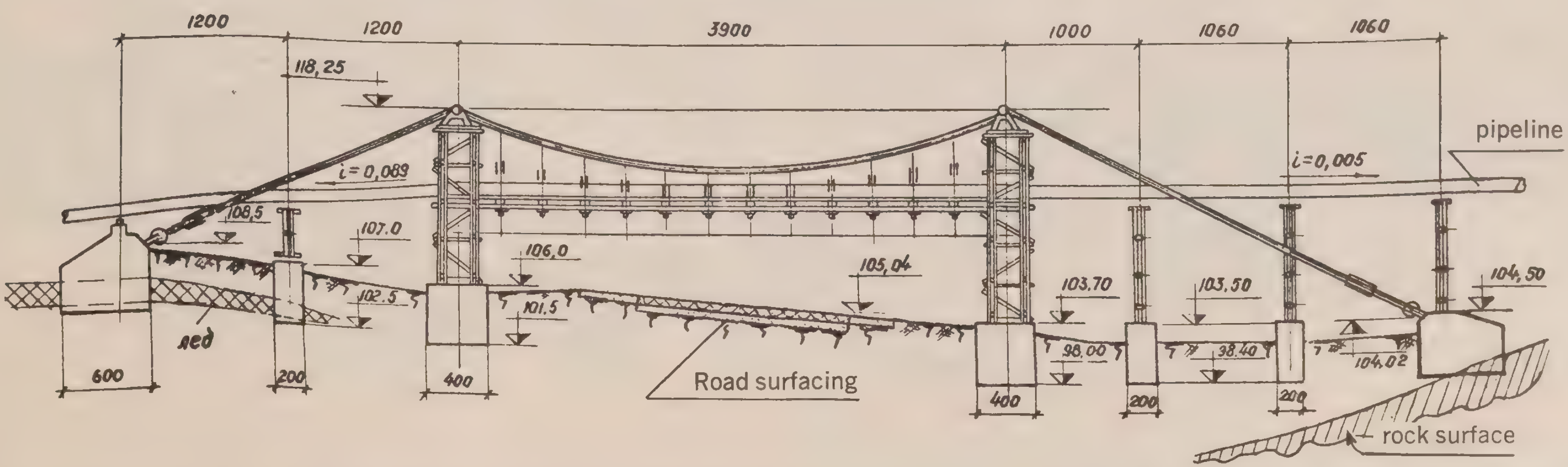
1. building;
2. underground conduit;
3. heating tracer line;
4. water main;
5. sewer;
6. special backfill
7. local soil;
8. insulation;
9. wooden support.



The outlet is insulated with mineral wool ($\delta = 50$ mm), two layers of sackcloth and two coats of hot bitumen (as suggested by the Research Institute of Civil Engineering in Yakutsk).

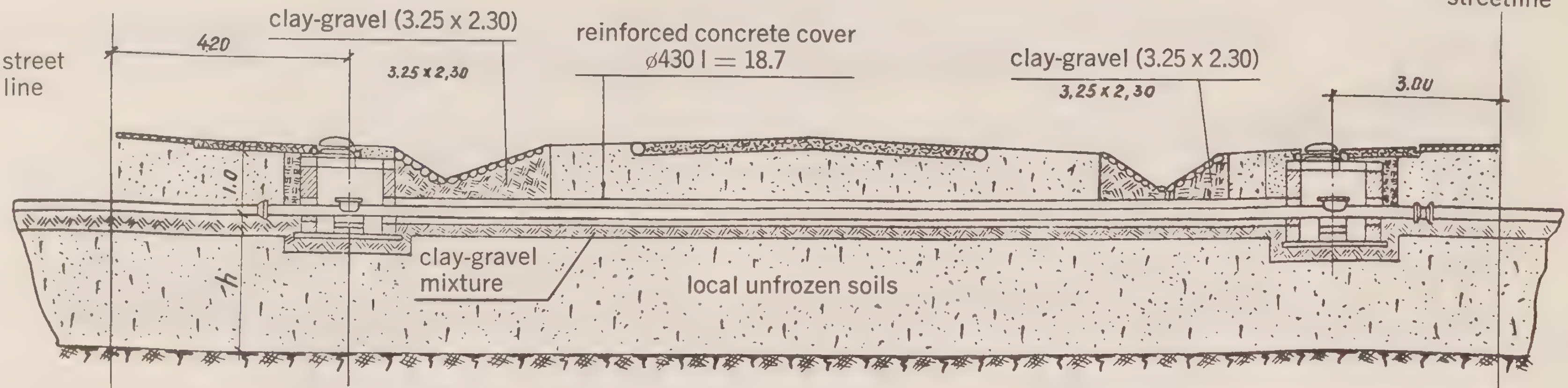

mm
Entrance header
Exit header
1500
Support
d=400
Clay coating 15 cm thick
900
1:1,5
1:1,5
700
350
250
250
350
Paving (15 cm) on gravel (10 cm)
350
1000
i=0,002
200
400
500
500
1500
1500
Clay gravel mixture
300
300
500
gravel and sand
Cemented crushed rock base
500
crushed rock or gravel
500
900
900
d=450
1800
Clay insulation
Catch basin
local soil
1:1,5
1:1,5
1000
Round reinforced concrete members
750
750
750
at least 250
1:1,5
250
400
250
1000
cobblestone paving
150
1000
i=0,003
150
200
200
concrete plate
support
d=200
1000
paving of ditch
ℓ=1500
350
4100
cemented crushed rock base


cm
Wooden lid (δ = 6.5 cm) covered with roofing iron
Reinforcements ø15 every 15 cm, l = 2.0m.
Cast iron manhole (to watermain) ø = 70 cm
Cobblestone paving δ = 20 cm on moss δ = 20 cm
road centreline
Cobblestone paving on moss, δ = 20 cm.
Soils which do not settle on thawing
Concrete bottom
concrete base m = 70
clay gravel mixture. δ = 30 cm
Reinforced concrete ring δ = 13 cm
Concrete pad δ = 20cm
Clay-gravel mixture δ = 27cm
Concrete bottom
Concrete base m = 70
Clay-gravel, 30 cm


pipeline
Road surfacing
rock surface

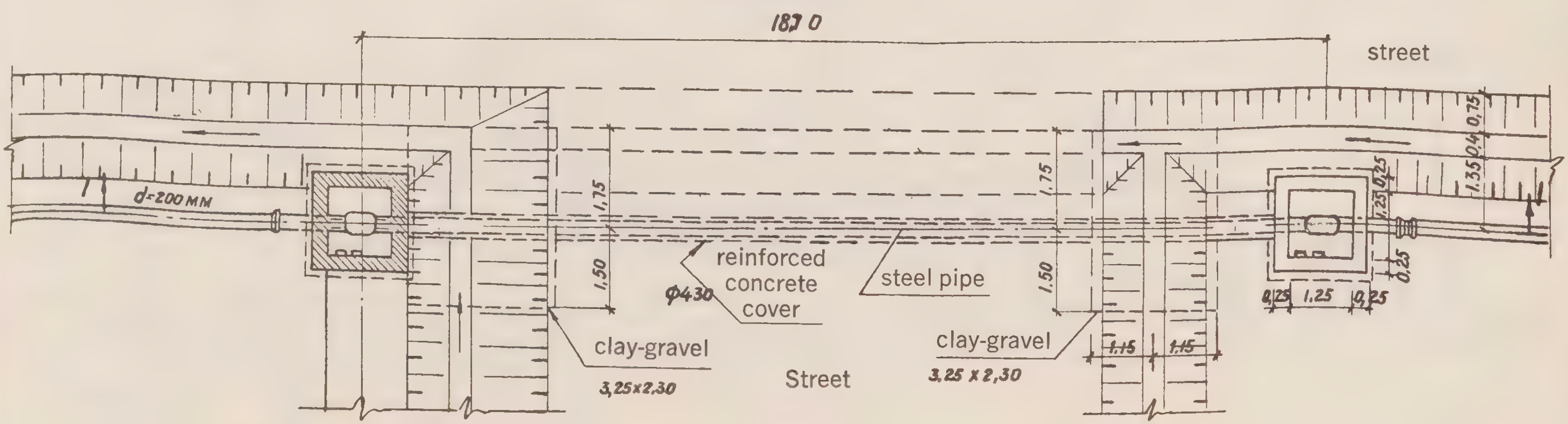
m

Cross section I-I



	board-walk	sidewalk	bench	gutter	shoulder	roadway	shoulder	gutter	bench	side walk	board-walk

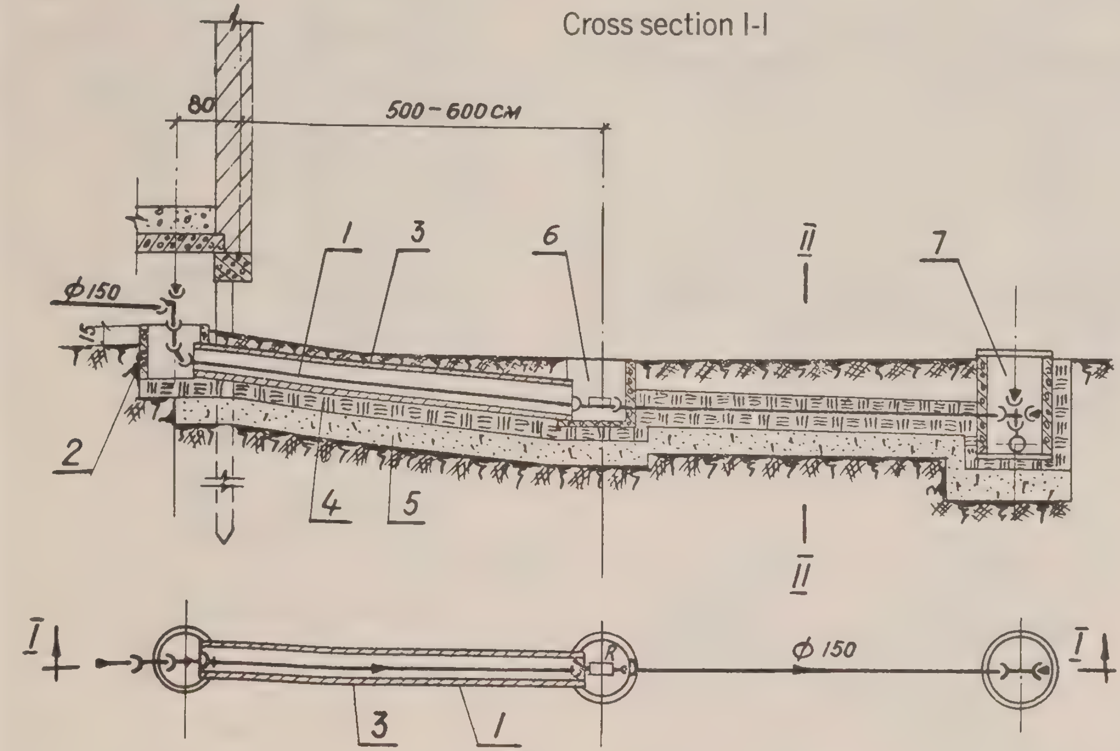
Plan view



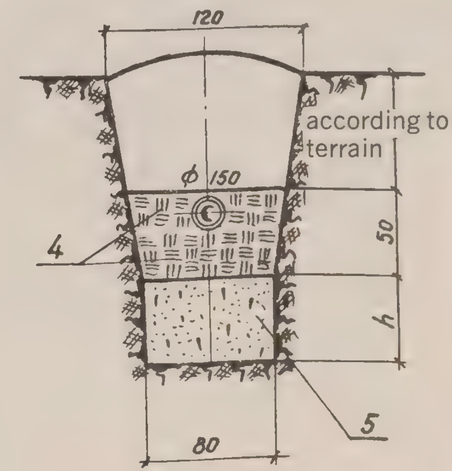
House connection and road crossing (Noril'sk, Dudinka)

cm

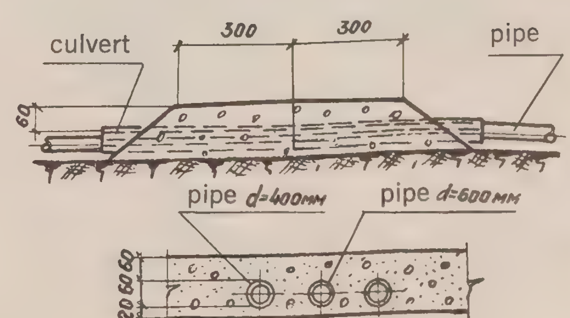
Cross section I-I



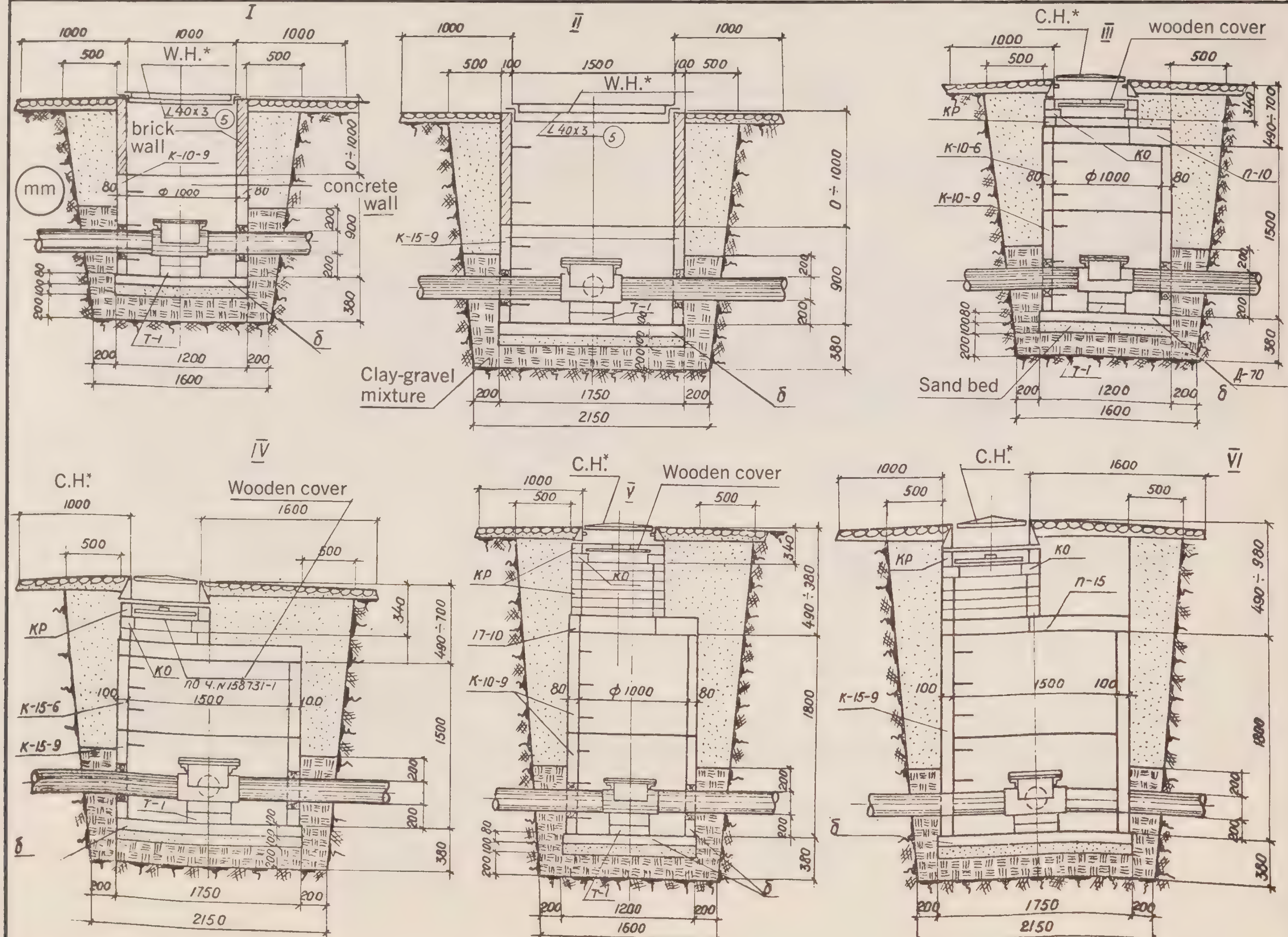
Cross section II-II



Road crossing in a steel culvert

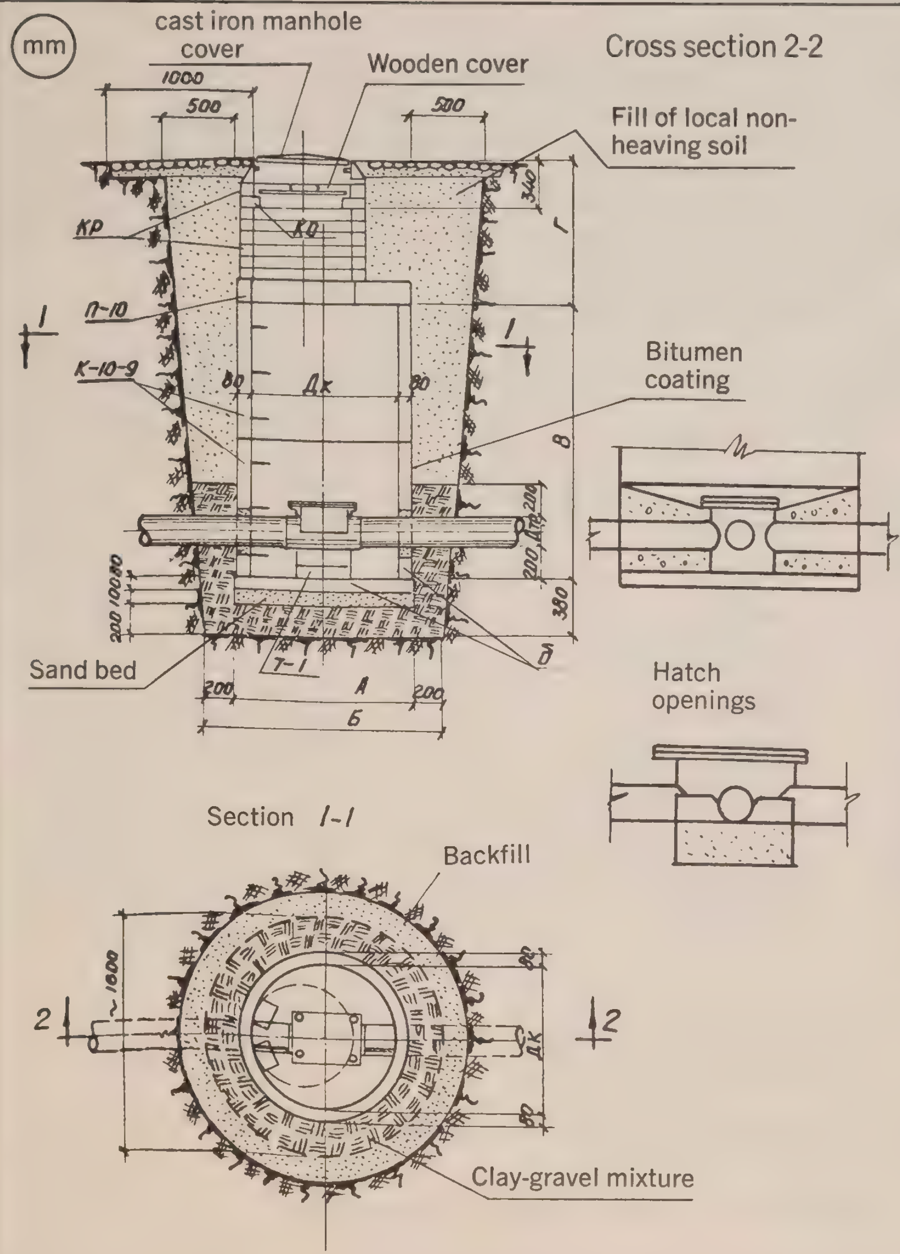


1. sewer; 2. sump; 3. steel culvert ø 500; 4. clay-gravel mixture;
5. special backfill; 6. ventilation shaft; 7. manhole on main sewer pipe.



*W.H. = welded manhole cover *C.H. = cast iron manhole cover

Precast reinforced concrete sewer manholes



Dimensions in mm

Depth of manhole	D manhole		A		B		C		D		δ cm	
	300	300	300	300	300	300	300	300	300	300	300	300
2 - 2.2m	1000	1500	1200	1750	1600	2150	1500	1500	490÷700	490÷700	7(10)	12,5(15)
2.3 - 2.8m	1000	1500	1200	1750	1600	2150	1800	1800	490÷980	490÷980	7(10)	12,5(15)

Volume of work per manhole

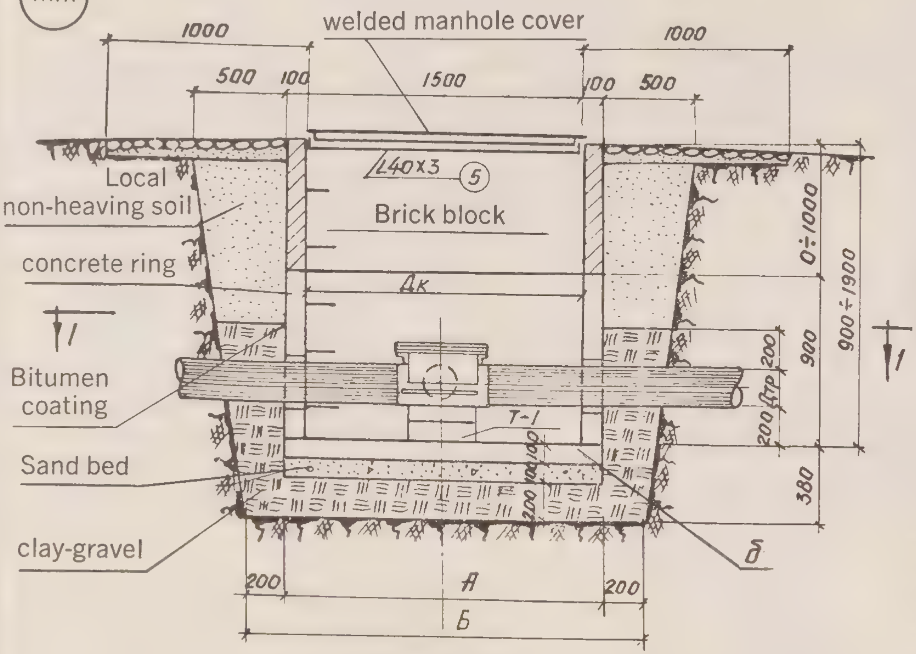
Item	Unit of meas	Depth 2.0 — 2.2 m		Depth 2.3 — 2.8 m	
		D<300 PIPE	D>300 PIPE	D<300 PIPE	PIPE
Excavation	м^3	6,6 ÷ 7,2	11,0 ÷ 12,0	7,5 ÷ 7,8	12,4 ÷ 14,7
Clay-gravel mixture	м^3	1,3	1,5	1,3	1,5
Sand bed	м^3	0,12	0,24	0,12	0,24
Back fill	м^3	4,5 ÷ 5,0	4,8 ÷ 5,0	5,1	5,1 – 6,7
Boarding	м^2	6,8	14	6,8	14.0
Concrete posts T-1	шт/м^3	2/0,03	2/0,03	2/0,03	2/0,03
Floors	шт/м^3	1/0,09	1/0,24	1/0,09	1/0,24
Cover plate n — 10	шт/м^3	1/0,10	—	1/0,10	—
Cover plate n — 15	шт/м^3	—	1/0,27		1/0,27
Supporting ring KO	шт/м^3	1/0,02	1/0,02	1/0,02	1/0,02
Brick laying KP	шт/м^3	6-18/0,015-0,04	5-18/0,014-0,04	6-42/0,014-0,1	6-42/0,014-0,1
Ring K — 10 — 6	шт/м^3	1/0,16	—	—	—
Ring K — 10 — 9	шт/м^3	1/0,24	—	2/0,48	—
Ring K — 15 — 6	шт/м^3	—	1/0,3	—	—
Ring K — 15 — 9	шт/м^3	—	1/0,45	—	2/0,9
Cast iron manhole cover	шт/кг	1/143	1/143	1/143	1/143
Wooden cover	шт	—	1	1	1
Clamps	шт	5	5	6	6

Precast reinforced concrete sewer manhole

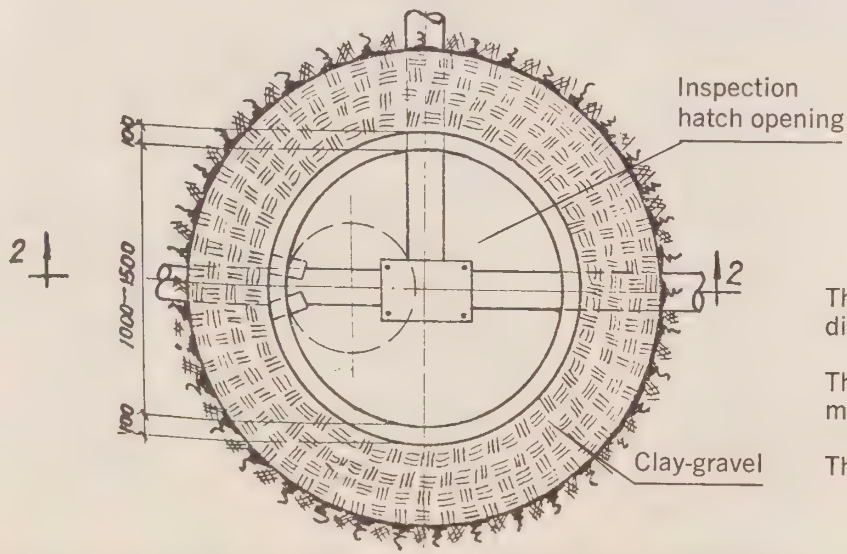
III – 32

mm

Section 2-2



Section 1-1



Dimensions in mm

Pipe diameter	D_K	A	B	$\delta_{см}$
$D_{pipe} < 300$	1000	1200	1600	7 (10)
$D_{pipe} > 300$	1500	1750	2150	12,5 (15)

Volume of work per manhole

Item	Unit	Volume	
		$D_{pipe} < 300$ (I)	$D_{pipe} > 300$ (II)
Excavation	m^3	4,3 – 6,6	6,0 – 10,6
Clay-gravel	m^3	1,3	1,5
Sand bed	m^3	0,12	0,24
Back fill	m^3	2,2 – 3,4	2,1 – 4,5
Boarding	m^2	6,8	14,0
Concrete posts T-1	no/m^3	2/0,03	2/0,03
Floors	"	1/0,09	1/0,24
Ring K – 10 – 9	"	1/0,24	—
Ring K – 15 – 9	"	—	1/0,45
Welded manhole cover	no/kg	1/37,0	1/69,5
Brick laying	m^3	0 – 0,3	0 – 0,53
Clamps	no.	5	5

The foundation soils are replaced depending on soil conditions along the route.

The volumes of work have been calculated for the maximum depths of manholes.

The joints are packed and sealed with cement grout.

IV. Thermal insulation of pipelines.

The pipelines installed above the surface of the ground or in underground conduits must be insulated to ensure reliable and efficient operation.

The insulation should have the following properties:

a) low moisture capacity and heat conductivity;

b) high resistance to frost and stable strength and insulation characteristics;

c) durability;

d) absence of any corrosive effects on the pipeline material;

e) good fire resistance;

f) resistance to biological decay;

The existing insulation materials do not satisfy all the aforementioned requirements and it is essential to improve them. The efficiency of available materials may however be improved by correct design and proper installation.

Where there is repeated freezing and thawing, the high moisture content also results in a sharp increase in the co efficient of heat conductivity. Therefore special care should be given to waterproofing the surfaces of pipelines.

At present the pipelines in the Far North are insulated with mineral wool, wood, and air entrained concrete. The pipes are protected from corrosion by Kuzbass lacquer* or bitumen and a layer of tar paper or ruberoid.

The thickness of the insulating layer is determined by calculations.

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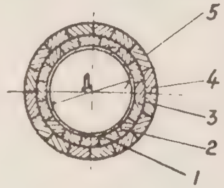
*Unable to determine composition.

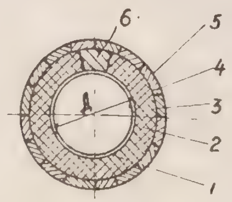
Thermal insulation of pipelines
Types of insulation

IV – 1

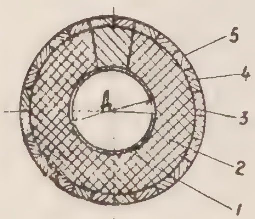
Thermal insulation of exposed watermain



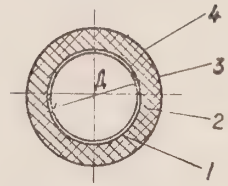
1. Kuzbass lacquer coating
2. Wood $\delta = 25$ mm
3. One layer of ruberoid
4. Wood $\delta = 25$ mm
5. Bitumen coating
   Wire ø 4 mm
   Wire ø 3 mm
   Wire ø 2 mm



1. Kuzbass lacquer coating
2. Mineral wool $\delta = 50$ mm
3. One layer of ruberoid
4. Wood $\delta = 20$ mm
5. Bitumen coating
   Wire ø 4 mm
   Wire ø 3 mm
6. Supporting block

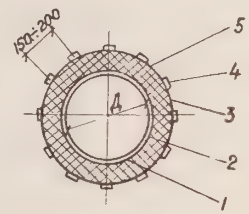


1. Kuzbass lacquer coating
2. Mineral wool $\delta = 100$ mm
3. One layer of ruberoid
4. Wood $\delta = 20$ mm
5. Bitumen coating
   Wire ø 4 mm
   Wire ø 3 mm



1. Kuzbass lacquer coating
2. Mineral wool $\delta = 50$ mm
3. Tarpauline (belting, sackcloth)
4. Fire-Resistant paint
   Wire ø 4 mm

Thermal insulation of water mains in covered conduits, crawl spaces etc.



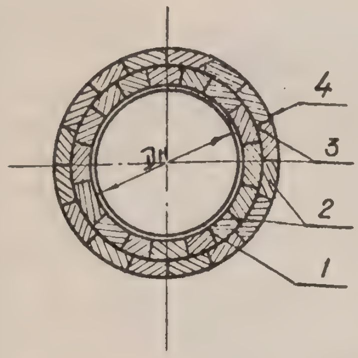
1. Kuzbass lacquer coating
2. Mineral wool $\delta = 50$ mm
3. Two layers of ruberoid
4. Lath
5. Bitumen coating
   Wire ø 4 mm

1. Mineral wool is bonded with bitumen
2. Types a, b, and c are wired every 800 mm
3. Types d and e are wired every 800 mm
4. Kuzbass lacquer and bitumen are applied twice
5. It is essential to clean the pipe surface prior to application of Kuzbass lacquer

Properties of insulating materials

Type	Unit wt. γ $\frac{kg}{m^3}$	Heat conductivity, λ $\frac{Kcal}{m.\ hr.\ deg.}$
1. Mineral wool	230	0.05
2. Wood (conifers) softwood	500-610	0.14
3. Ruberoid	600	0.12

Insulation of exposed watermains (D > 150 mm) with wooden lath (Noril'sk)	IV – 2



Consumption of materials per linear meter of pipeline

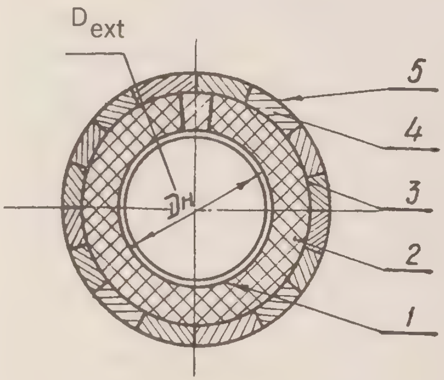
	Materials	Unit of meas.	External diam. of pipeline D_{ext} mm									
			159	219	273	325	426	529	630	720	820	920
1.	Kuzbass lacquer coating	m^2	0,50	0,69	0,86	1,02	1,34	1,66	1,98	2,26	2,58	2,89
2.	Wooden stave $\delta = 25$ mm	m^3	0,03	0,04	0,05	0,06	0,08	0,09	0,11	0,12	0,13	0,15
3.	One layer of ruberoid	m^2	0,66	0,85	1,01	1,18	1,50	1.82	2.14	2.42	2.73	3,05
4.	Bitumen coating	m^2	0,85	1.03	1,20	1.37	1.68	2	2,33	2,61	2,92	3,23
	Wire ø 4 mm	kg	0,01	0.01	0,01	0.01	0,01	0,02	0,02	0,02	0,02	0,03
	Wire ø 3 mm	kg	0,02	0,03	0,03	0,04	0,05	0,06	0,07	0,08	0,09	0,10
	Wire ø 2 mm	kg	0,07	0,08	0,09	0,10	0,13	0,15	0,17	0,19	0,21	0.24

Properties of insulating materials

	Materials	Unit wt. γ $\frac{kg}{m^3}$	Heat Conductivity, λ $\frac{Kcal}{m.hr.deg.}$
1.	Wood (conifers)	500-610	0.14
2.	Ruberoid	600	0.12

1. Wiring should be done every 800 mm.
2. There should be two applications of Kuzbass lacquer or bitumen.
3. It is essential to clean the pipe surface prior to the application of Kuzbass lacquer.

Insulation of exposed watermains (D = 70 – 500 mm) with mineral wool (Noril'sk)	IV – 3



Consumption of materials per linear m of pipeline

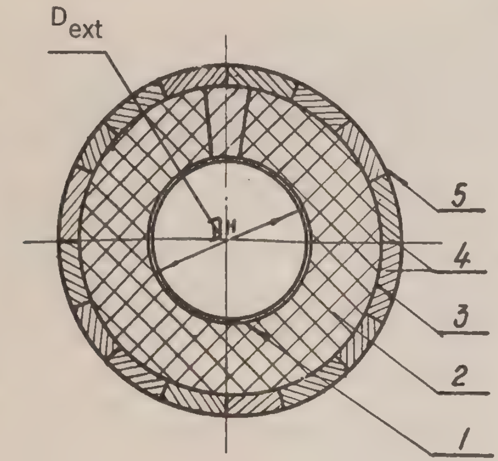
	Material	Unit of meas.	External diam. of pipe, mm									
			76	89	108	133	159	219	273	325	426	529
1.	Kuzbass lacquer	m^2	0,24	0,28	0,34	0,42	0,50	0,69	0,86	1,02	1,34	1,66
2.	Mineral wool δ = 50 mm	m^3	0,02	0,02	0,02	0,03	0,03	0,04	0,05	0,06	0,07	0,09
3.	One layer of ruberoid	m^2	0,55	0,59	0,65	0,74	0,81	1.00	1.17	1.33	1.65	1.38
4.	Wood δ = 20 mm	m^3	0,01	0,01	0,01	0,02	0,02	0,02	0,03	0,03	0,03	0,04
5.	Bitumen	m^2	0,71	0,75	0,81	0,89	0,97	1,16	1,33	1,49	1,81	2,13
	Wire ø 4 mm	kg	0,01	0,01	0,01	0.01	0,01	0,01	0,01	0,01	0,01	0,01
	Wire ø 3 mm	kg	0,02	0,06	0,06	0,07	0,07	0,09	0,10	0,11	0,13	0,16

Properties of insulating materials

	Material	Unit wt. γ $\frac{kg}{m^3}$	Heat Conductivity, λ $\frac{Kcal}{m.\ hr.\ deg.}$
1.	Mineral wool (dry)	230	0,05
2.	Wood (conifers)	500 – 610	0,14
3.	Ruberoid	600	0,12

1. Mineral wool is bonded with bitumen.
2. Wiring should be done every 800 mm.
3. Kuzbass lacquer or bitumen are applied twice.
4. It is essential to clean the pipe surface prior to the application of Kuzbass lacquer.

Insulation of exposed watermains (D > 500 mm) in Noril'sk	IV – 4



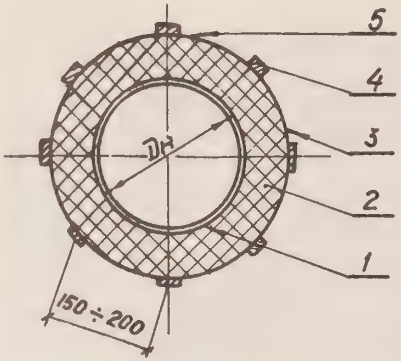
	Material	Unit of Meas.	External diam. of pipe, mm				
			630	720	820	920	1020
1.	Kuzbass lacquer	m^3	1.98	2,26	2.58	2.89	3,20
2.	Mineral wool $\delta = 100$ mm	m^3	0,23	0,26	0,29	0,32	0,35
3.	One layer of ruberoid	m^2	2,61	2,89	3,20	3,52	3,83
4.	Wood δ 20 mm	m^3	0,05	0,06	0,07	0,07	0,07
5.	Bitumen	m^2	2,77	3,05	3,36	3,67	3,99
	Wire ø 4 mm	kg	0,02	0,02	0,03	0,03	0,03
	Wire ø 3 mm	kg	0,20	0,22	0,24	0,26	0,29

Properties of insulating materials

	Material	Unit wt. γ $\frac{kg}{m^3}$	Heat Conductivity λ $\frac{Kcal}{m.\ hr.\ deg.}$
1.	Mineral wool (dry)	230	0,05
2.	Wood (conifers)	500 – 610	0,14
3.	Ruberoid	600	0,12

1. Mineral wool is bonded with bitumen.
2. Wiring should be done every 800 mm.
3. Kuzbass lacquer or bitumen are applied twice.
4. It is essential to clean the pipe surface prior to the application of Kuzbass lacquer.

Insulation of pipelines (D = 70 – 500 mm) installed in conduits, crawl spaces etc. (Noril'sk)	IV – 5



Consumption of materials per linear m of pipeline

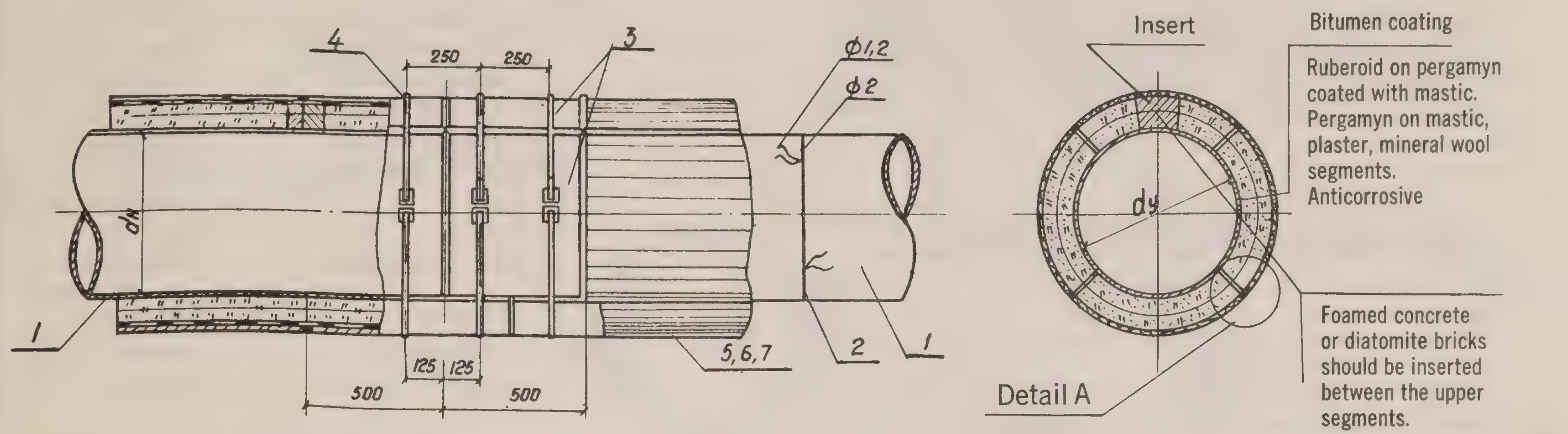
	Material	Unit of Meas.	External diam. of pipe, mm									
			76	89	108	133	159	219	273	325	426	529
1.	Kuzbass lacquer	m^2	0,24	0,28	0,34	0,42	0,50	0,69	0,86	1,02	1,34	1,66
2.	Mineral wool δ = 50 mm	m^3	0,02	0,02	0,02	0,03	0,03	0,04	0,05	0,06	0,07	0,10
3.	Ruberoid (two layers)	m^2	0,55	0,59	0,65	0,74	0,81	1,00	1.17	1,33	1.65	1.98
4.	Lath	lin. m	4.0	4.0	4.0	4.0	4.0	6.0	6.0	8.0	8.0	10,0
5.	Bitumen	m^2	0,59	0.63	0,69	0,76	0,85	1,03	1,20	1,37	1,68	2,01
	Wire ø 4 mm	kg	0,03	0,03	0,04	0,04	0,05	0,05	0,06	0,07	0,08	0,10

Properties of insulating materials

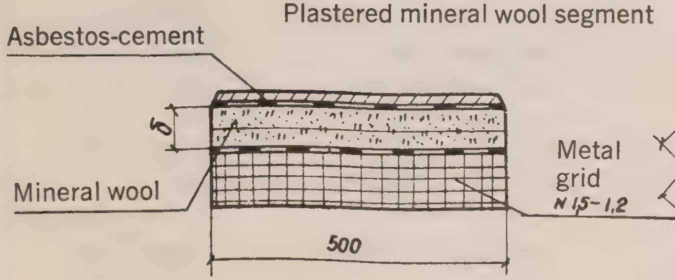
	Material	Unit wt. γ $\frac{kg}{m^3}$	Heat Conductivity λ $\frac{Kcal}{m. hr. deg.}$
1.	Mineral wool (dry)	230	0,05
2.	Ruberoid	600	0.12

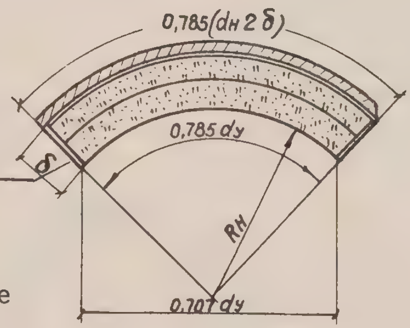
1. Mineral wool is bonded with bitumen.
2. Wiring is required every 500 mm.
3. Kuzbass lacquer or bitumen are applied twice.
4. It is essential to clean the pipe prior to the application of Kuzbass lacquer.

Mineral wool insulation (Noril'sk)

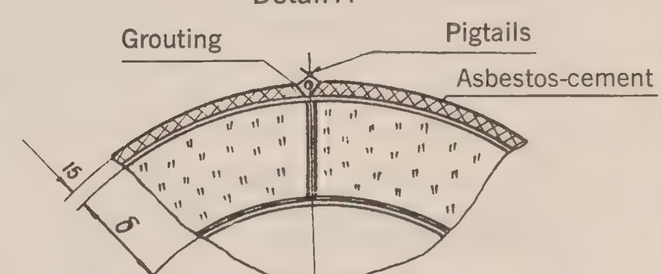


Plastered mineral wool segment





Detail A



$d_н$ – external diam. of pipe d_y – internal diam. of pipe

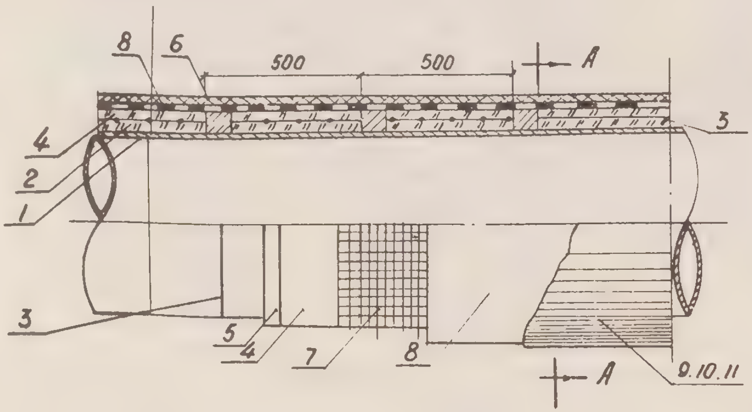
1. Install insulation in the order given in the Table. **2.** Fasten plastered mineral wool segments to wire rings (ø 2 mm) by pigtails (ø 1.2 mm). Space rings at 500 mm and pigtails at 0.785 of the outside diameter measured along the circumference of the ring. **3.** Seal joints in the plaster with grouting. **4.** Place plastered mineral wool segments in a staggered pattern. **5.** The thickness of the insulating layer (δ cm) is found by calculation. **6.** The design may be used for $d_y = 300 - 600$. **7.** Applicable for temperatures up to 200°C.

Item	Material
1. Anticorrosive coating	Bitumen
2. Rings with pigtails	Wire ø 2 Wire ø 1.2
3. Insulation layer with plaster	Plastered mineral wool segments
4. Bindings	Strips 20 x 0.7
5. First waterproof layer	Pergamyn
6. Second waterproof layer	Ruberoid
7. Top coat	Bitumen

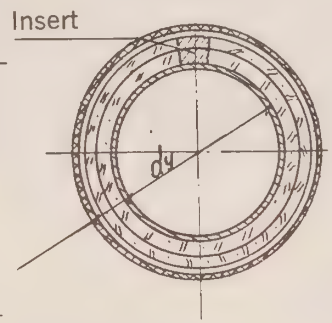
Mineral wool insulation of pipelines (Noril'sk)

IV – 7

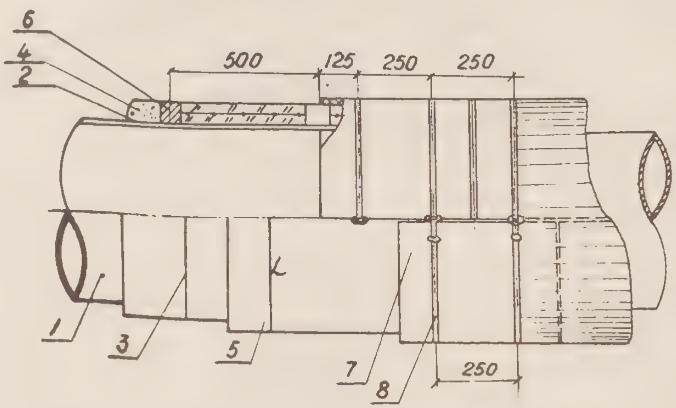
Pergamyn, ruberoid, bitumen coating. Asbestos-cement plaster. Galvanized net ø 1.2 mm Gost 5336-50 (Soviet standards. Transl). 2nd mineral wool layer bonded with bitumen. Gost 6125-52. 1st mineral wool layer bonded with bitumen. Gost 6125-52. Anticorrosive coating.

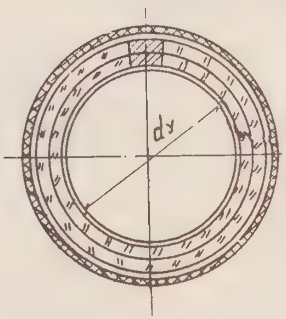


Section A-A



Item		Material
1.	Anticorrosive coating	Bitumen
2.	1st layer of insulation	Mineral wool
3.	Coil, 100 - 150 mm pitch	Wire ø 2
4.	2nd layer of insulation	Mineral wool
5.	Coil, 100 - 150 mm pitch	Wire ø 2
6.	Insert	Foamed concrete, M 500
7.	Metal net	N 15 - ø 1.2
8.	Asbestos-cement plaster $\delta = 15$ mm	Category IV asbestos M250 cement
9.	1st waterproof layer	Pergamyn
10.	2nd waterproof layer	Ruberoid
11.	Top Coat	Bitumen





Item		Material
1.	Anticorrosive coating	Bitumen
2.	1st layer of insulation	Mineral wool
3.	Coil, 100 - 150 mm pitch	Wire ø 2
4.	2nd layer of insulation	Mineral wool
5.	Coil, 100 - 150 mm pitch	Wire ø 2
6.	Insert	Foamed concrete M 500
7.	Asbestos-cement shells, $\delta = 15$ mm	Asbestos-cement
8.	Bindings	Strips 20 x 0.7
9.	1st waterproof layer	Pergamyn
10.	2nd waterproof layer	Ruberoid
11.	Top Coat	Bitumen

Water Intake Structures

Owing to inadequate knowledge of the sources of water supply and the absence of general data on construction and operation of water intakes in the Far North, the present section contains only a few examples of water intake structures on the shores of open bodies of water. All water intakes described here are operating satisfactorily in the northern parts of the Krasnoyarsk Krai and the Yakut ASSR.

Water supply engineers working in the Far North are faced with a wide variety of hydrological, hydrogeological, and permafrost conditions. It is possible, therefore, to indicate only very general ideas concerning the construction of water intakes.

Water is obtained from large rivers and lakes, which do not freeze completely (over 3 m deep in winter) and which have a year-round supply and flow, by means of an intake constructed in the channel or on the shore, sometimes in conjunction with drains and galleries. Siphon-suction lines are laid below the river bed or on trestles. If the water is low in winter and the channel becomes partially frozen, water is obtained by means of an intake on the shore in the summer and a subchannel drain (gallery) in winter.

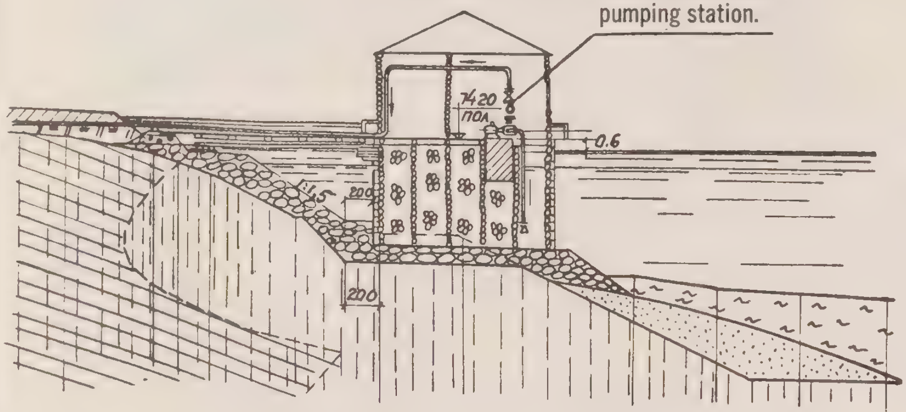
To improve the water supply in winter, temporary dikes or dams may be constructed on rivers. Water reservoirs and artificial ponds may be built in the case of rivers and creeks which freeze completely in winter.

It is recommended that the water intake structures be built as close as possible to the shore on unfrozen or dense frozen soils which will not settle on thawing. It is essential to prevent icing by insulating the structures and heating the intakes and the water.

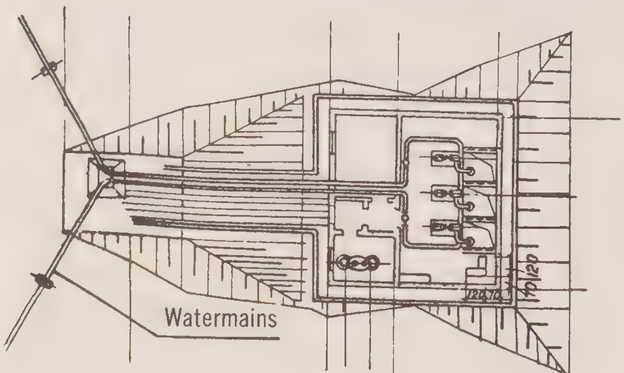
Water intakes
Examples of water intakes in Dudinka and Kadykchan

Pumping station on a lake in Dudinka

Cross section



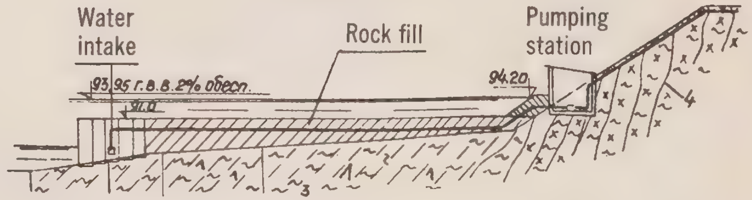
Plan view



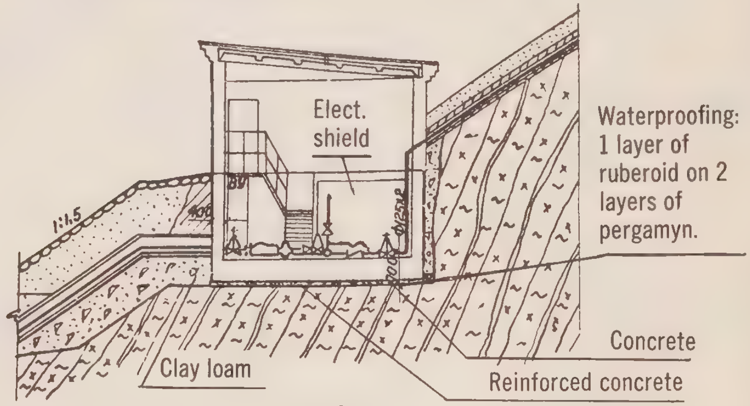
1. Lacustrine silt with up to 15% gravel and high water content.
2. Medium and heavy clay loam with up to 15% gravel.
3. Frozen soil
4. Fine-grained sand with a high content of gravel.

Structures in Kadykchan

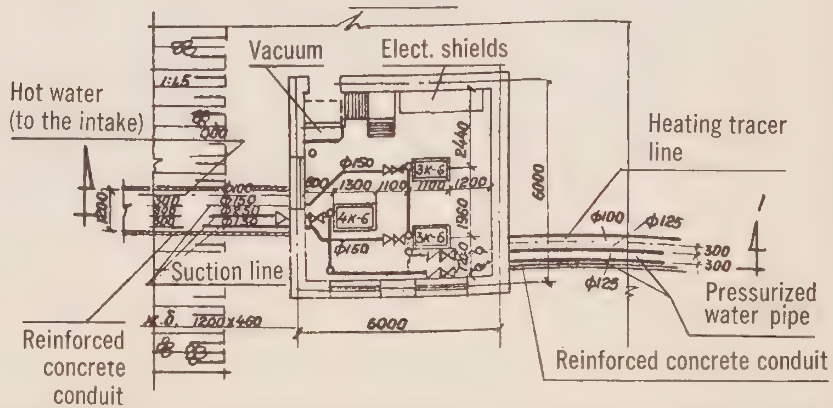
Cross section



1. Rock waste & sand
2. Silty sandy loam with plant remains.
3. Silt with plant remains.
4. Fractured porphyrite.

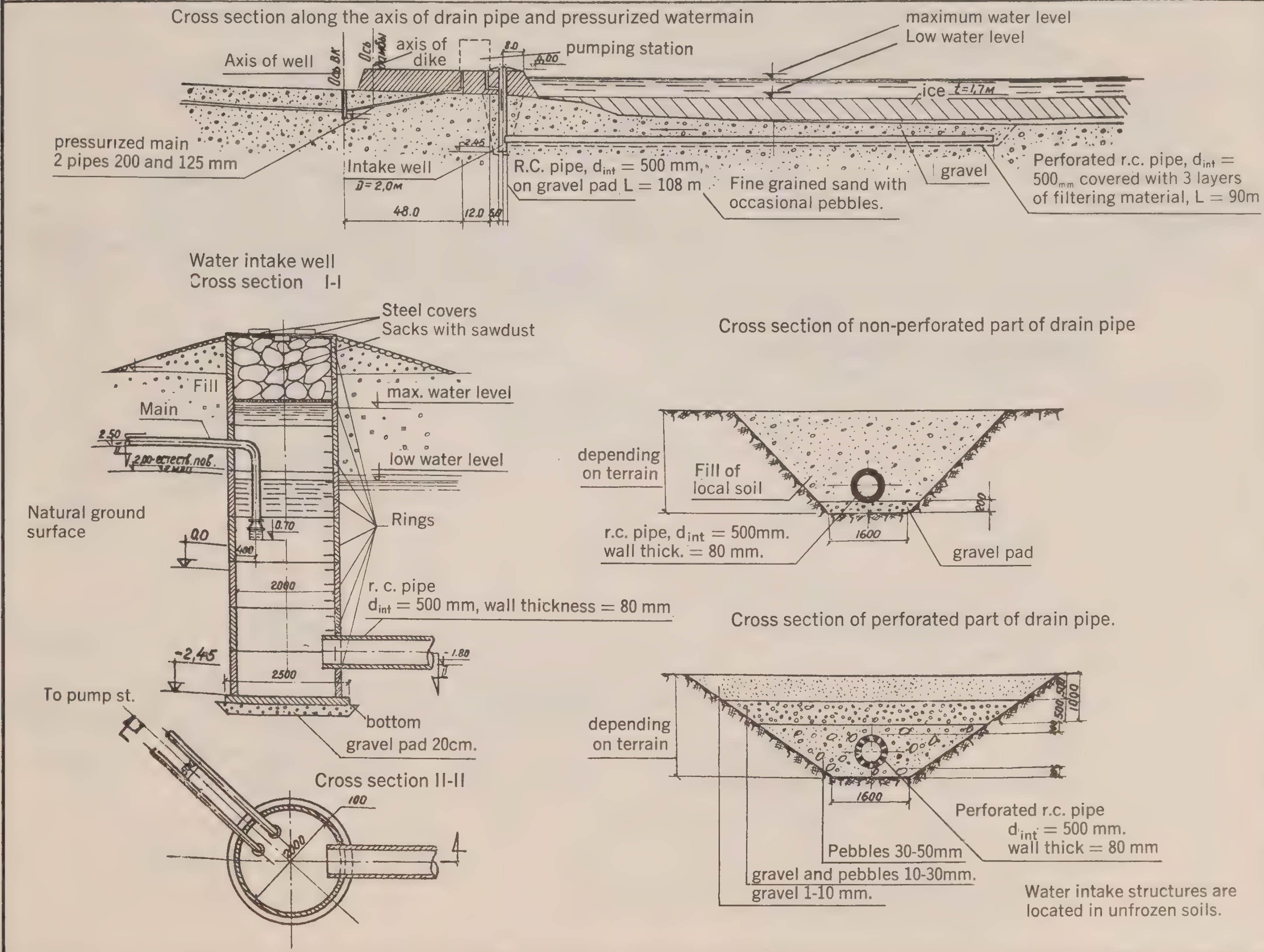


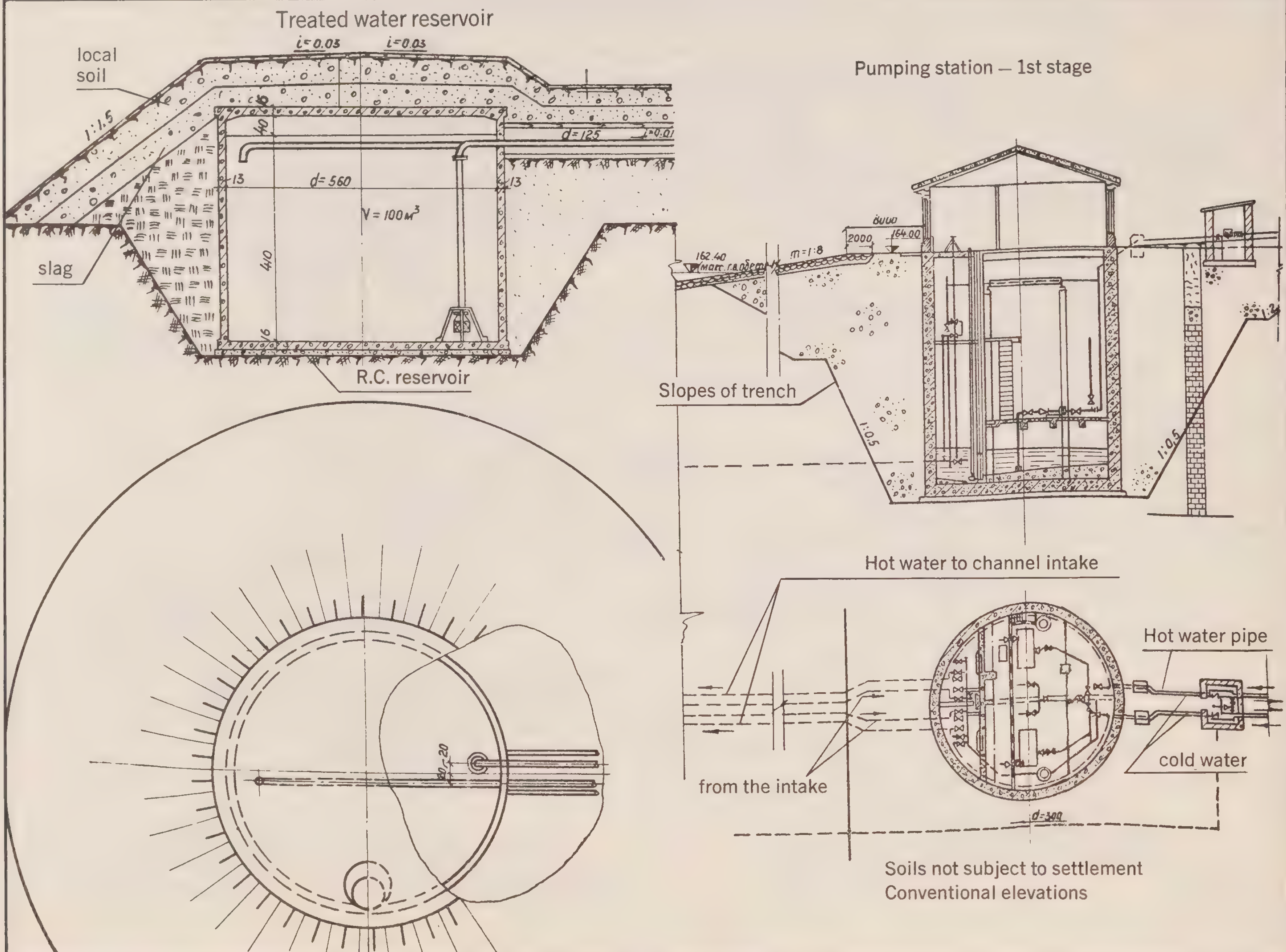
Plan view



Intake well, drain pipe, pressurized watermain

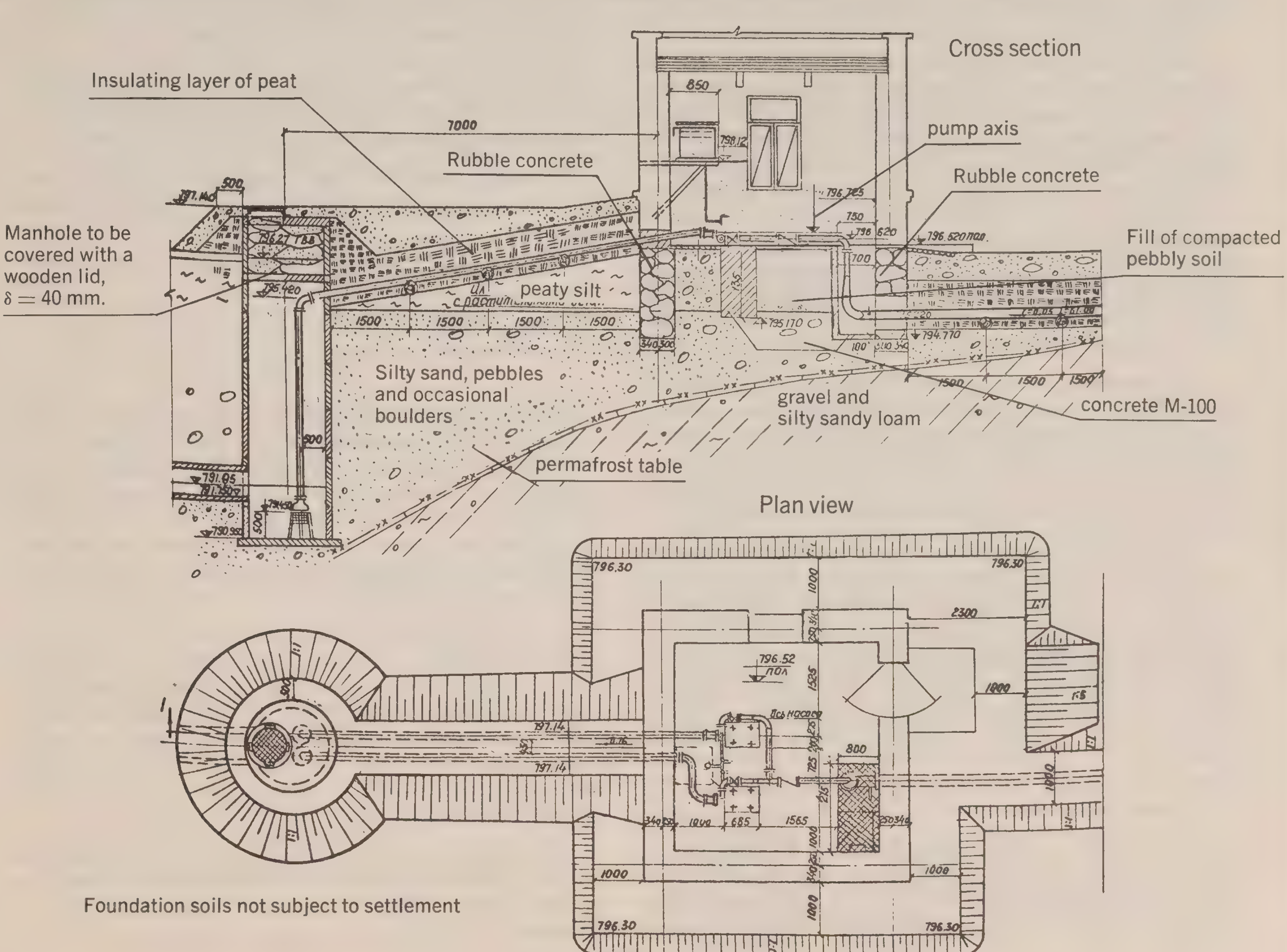
V – 2





Soils not subject to settlement
Conventional elevations

Intake Well. Pumping Station (Lake Dolgoe in Noril'sk)	V – 4



Suggestions for rational designs of sewage treatment structures

The present suggestions are intended for use in the design of individual sewage treatment structures in the settlements in the Far North. These suggestions are needed because of the lack of proven designs for individual sewage treatment structures and complete plants, which would be applicable under severe climatic conditions and would satisfy the specific construction requirements in the Far North. The existing standard designs of low output sewage treatment plants are not intended for use in permafrost, while their modifications do not give satisfactory results. The two-level settling tanks and trickling biofilters incorporated in standard structures have low outputs and awkward designs.

The present suggestions include high output devices of Soviet design known to be absolutely reliable. Other equally promising structures, as for example the biofilters with a plastic medium, high rate aeration tanks, etc., have not been included here since there are no data on their performance in sewage treatment plants, even under favourable climatic conditions.

The sewage treatment process is based on biochemical purification with preliminary mechanical separation and digestion of the solids. The mechanical purification may be accomplished by means of clarifier-digestors, designed at the Leningrad Institute of Construction Engineering. These digestors were tested in 1967-68 under operational conditions close to those in the Far North. For biochemical purification use may be made of high-rate biofilter settling tanks. The design of secondary settling tanks combined with biofilters differs from standard designs and renders it possible to reduce the hydraulic losses to 0.5 – 1.0 m.

Owing to lack of reliable information on the composition and treatment of sewage in the Far North, the designs described here are based on data in SNiP II-G. 6 – 62. The designs will be corrected as more information becomes available on the operation of experimental systems described in this handbook. The amount of contamination per capita was taken from Table 25 in SNiP II-G. 6 – 62 (this will be referred to simply as SNiP in the treatment that follows, since this is the only standard quoted in this appendix). The daily consumption of water per capita in the settlements in the Far North must be taken as not less than 200 litres, to meet modern requirements. The suggested designs are based on a daily consumption of 300 litres per capita which is more characteristic of small settlements.

The temperature of sewage in the middle of winter is taken as 10°C, as suggested by actual measurements quoted in the literature.

The designs of individual structures are given below.

Sand Trap

The climate in the Far North is characterized by a very short period when precipitation is in the form of rain. Only a small amount of sand enters the sewers, because the surface area of waterproof pavements in the settlement is negligible, while the periods of rainfall and snow melting are short. Therefore most of the time the sand trap will play a protective role only. Nevertheless, in preliminary designs the amount of sand is to be taken from data in SNiP.

A vertical sand trap is most suitable from the point of view of layout, installation, and method of sand removal. A sand trap with a circular movement of liquid is unsuitable, because its minimum diameter is 3 m, which in turn increases the volume of the sand-containing part. In a horizontal sand trap with a linear movement of liquid it is not possible to mechanize the sand removal process and therefore it is also unsuitable for small sewage treatment structures.

The vertical sand trap recommended here is combined with a surge chamber and is made of metal. The initial design data are taken from "Small sewage treatment systems" by A.I. Vasilenko, Kiev, 1964.

Calculations for Vertical Sand Trap

1. The height of the settling tank h_n is found from:

$$h_n = V \times t \text{ (in m)},$$

where

V is the upward velocity of liquid at maximum inflow (recommended figure is 0.05 m/sec.);

t is the duration of settlement of sand in seconds (0.5 to 2.5 minutes, i.e. 30 to 150 sec.)

2. The cross section of the settling tank is equal to:

$$F = \frac{q_p}{V} \text{ or } F = a \times 2b \text{ (in m}^2\text{)},$$

where

q_p is the specified maximum discharge of sewage in m^3/sec; a and b are the width and the length of one section of the sand trap depending on the design.

3. The cross sectional area of the intake channel must be such that the velocity V in the intake would not exceed 100 mm/sec. Consequently, h_o is equal to:

$$h_o = a' = \frac{q_p}{b \times V} \quad \text{(in m)}.$$

4. The height of the cone h_k, at the angle of inclination of its walls equal to 50° is found from the expression:

$$tg\alpha = \frac{2h_k}{a' + a}$$

5. The overall height of the sand trap is equal to:

$$H_n = h_\delta + h_H + h_o + h_k + h_n \text{ (in m)},$$

where

h_δ is the height of unfilled section equal to 0.2 – 0.3 m in accordance with SNiP

h_H is the height of liquid in the outlet channel;

h_n is the height of the settling chamber;

h_o is the height of the inlet channel;

h_k is the height of the settling cone,

(all in m).

6. The total amount of trapped sand (0.02 litres/person as specified in SNiP is found from the following equation:

$$W_{day} = N \times P \text{ (in m}^3\text{)},$$

where N is the number of residents;

P is the amount of trapped sand per resident per day (in litres).

Clarifier-digestor

This structure is recommended for mechanical treatment of sewage and sludge digestion and is intended to replace the two-level settling tanks. The latter have several disadvantages:

a) the settling gutters are too short (6 – 8 m), which greatly affects their efficiency;

b) the digestion process cannot be controlled;

c) the part where settling takes place is connected with the digesting chamber, which leads to repeated contamination of the liquid;

d) the design renders it impossible to change the volume of the digesting chamber.

The clarifier-digestor is free of these defects.

The present handbook gives two versions of clarifier-digestor: for mechanical purification of sewage prior to bio-chemical treatment by activated sludge process, and clarifier-digestors with biofilters. The layouts of clarifier-digesters of both types are shown in this manual.

For the sake of convenience the digestion chamber is rectangular in plan view. The clarifier with natural aeration may be rectangular, square or round. Round clarifiers have been developed for sewage treatment in meat processing plants (standard designs of the Soyuzvodokanalproekt series 4 – 18 – 826, 1964). Their diameters are 4. 5 and 6 m and they may be used in individual structures almost without modifications.

The basic initial data for the design of clarifiers with natural aeration are given in SNiP, paragraph 6.57. The designs of round clarifiers are determined as follows:

1. The volume of the flocculation chamber W is calculated on the assumption that water will remain in it for 20 minutes:

$$W = q_p \times t \text{ (in } m^3)$$

2. The height of the flocculation chamber H must not be less than 3.5 m, while the height of its conical part ($h_{k\phi}$)* must not be less than 1.0 m. The reduced (to the equivalent volume of the flocculation chamber) height H_R will be approximately equal to:

$$H_R = h_{k\phi} + 2/3\, h_{k\phi} \text{ (in m)}$$

3. The approximate cross section of the flocculation chamber will be:

$$w = \frac{W}{H_R} \text{ (in } m^2)$$

4. The diameter of the flocculation chamber ($d_{k\phi}$) is found as follows:

$$d_{k\phi} = \sqrt{\frac{4 \times w}{\pi}} \text{ (in m)}$$

5. The diameter of the lower opening in the flocculation chamber ($d_{H.O.}$) is found from the following equation:

$$d_{H.O} = \sqrt{\frac{4 \times q_p}{\pi \times V}} \text{ (in m),}$$

where V is the velocity of water on leaving the chamber equal to 8-10 mm/sec.

These parameters may be used to correct the volume of the flocculation chamber.

---

*Note:
1. It has been necessary to leave certain symbols on diagrams in their original form because of reprinting difficulties.
Parenthesis indicates an original symbol which will later appear in the diagrams.
2. Formulae have been simplified in most cases, retaining original symbols wherever possible.

6. The settling area of the clarifier w' is found from the upward velocity of water V_u equal to 0.8-1.0 mm/sec:

$$w' = \frac{q_p}{V_u}, \text{ (in } m^2)$$

7. The cross section of the clarifier w_c is equal to the sum of the areas of the flocculation chamber and the part where settling takes place, i.e.,

$$w_c = w + w' \text{ (in } m^2)$$

8. The diameter of the clarifier is found as follows:

$$D_o = \sqrt{\frac{4 \times w_c}{\pi}} \text{ (in m)}$$

9. The diameter of the central pipe d_c ($d_{\text{цmp}}$) is equal to:

$$d_c = \sqrt{\frac{4 \times q_p}{\pi \times V}}, \text{ (in m)}$$

where V is the rate of flow of the liquid in pipe equal to 0.5-0.7 m/sec.

10. The volume of the sludge W_s (45 grams per capita/day) with a moisture content of 95%, stored for 24 hours, will be:

$$W_s = \frac{45 \times N \times 100}{(100 - 95) \times 10^6} \text{ (in } m^3),$$

where N is the number of persons.

11. The height of the conical part of the clarifier (h_{ko}) (inclined at an angle of 50°) is found as follows:

$$h_{ko} = \frac{Do}{2} \times tg\alpha \text{ (in m),}$$

12. The overall height of the clarifier will be:

$$H_c = H_\delta + H + h_{ko}$$

where: $H = h_{k\phi} + h + h_{\text{цmp}}$

h_δ is the height of the unfilled section.

Design of Digestor

The design of the digestor is similar to that of the septic chamber in a two-level settling tank. However, it is not possible to use Table 32 given in SNiP, since the working principle of the digestion chamber differs somewhat from that of the septic chamber of two level clarifiers.

L.M. Chesnova[45] has recommended the following digestor loadings depending on the temperature of sewage (see Table). The data in the Table are based on sludge digestion for domestic sewage in digestors mixed by recycling by pumping.

Recommended Digestor Loading

Temp. of digestor liquid °C	6	7	8.5	10	12	15	20
Amount of sludge loading, D in %	0.72	0.85	1.02	1.28	1.70	2.57	3.0

For complete purification of sewage in accordance with the explanatory notes to Table 32 in SNiP the volume of the digestion chamber must be increased by 70% if excess activated sludge from aeration tanks or the biofilm from the high rate biofilters is introduced. To design the digestion chamber, attention should be given also to paragraph 6.51 in SNiP.

The total volume of raw sediment and excess activated sludge or biofilm W_{tot} are found as follows:

$$W_{tot} = 1.7\left[\frac{45 \text{ x } N \text{ x } 100}{(100 - W'_m)}\right] \text{ x } 10^6 \text{ (in m}^3\text{)},$$

where 1.7 is the coefficient taken from explanatory notes to Table 32 in SNiP; N is the number of persons, W'_m is the moisture content of the sludge in percent,

$$W_{tot} = (1.1 \text{ to } 1.2)\left[\frac{45 \text{ x } N \text{ x } 100}{(100 - W'_m)10^6}\right] + \frac{28 \text{ x } N \text{ x } 100}{(100 - W'_s)\,10^6} \text{ (in m}^3\text{)}.$$

where W_s is the moisture content of sludge in percent: 1.1 - 1.2 is the coefficient which accounts for the increase in the amount of the sludge due to coarse fractions of suspended matter not included in the samples for analysis.

The volume of the digestion chamber W_d is found as follows:

$$W_d = \frac{W_{tot} \text{ x } 100}{D} \text{ (in m}^3\text{)}$$

where D is the sludge loading, in percent.

The dimensions of the digestor (in plan view) depend on how it is combined with the biofilter – settling tank or aeration tank.

The height of the conical part of the digestor depends on the angle of inclination of its walls (at least 30°).

Biofilter with Settling Tank

The biochemical treatment of sewage may be accomplished by means of a biofilter combined with a settling tank. This structure represents one of a number of possible combinations of a high rate biofilter with a secondary settling tank. The high rate biofilters are sufficiently well known and have proven themselves well in practice. Their oxidation power is at least twice as high as that of trickling biofilters. Large amounts of crushed rock and gravel present almost everywhere in the Far North simplify the charging of filters.

The design of the secondary settling tank recommended here has been simplified as compared with the standard design. Its operational principle is based on a more or less uniform distribution of liquid on the surface of the biofilter. The tank must be tested under operational conditions prior to its adoption as a standard design.

High-rate Filter

The concentration of sewage entering the biofilter after mechanical treatment in the clarifier-digester is found as follows:

$$BOD_{20} = \frac{40 \times 1{,}000}{q} \times 0.85 \text{ mg/litre;}$$

$$K_{ss} = \frac{65 \times 1{,}000}{q} \times 0.3 \text{ mg/litre}$$

where 40 and 65 are the amounts of impurities per person per day with respect to BOD and suspended solids; q is the specified water consumption in litres/capita/day; K_{ss} is the concentration of suspended solids in the treated liquid; 0.85 and 0.3 are the amounts of impurities left in the sewage with respect to BOD_{20} and suspended solids.

The biofilters should have at least two sections. However, if the sewage discharge is less than 300 m^3/day, it is expedient to provide one section only. The main elements of biofilters are designed and constructed according to SNiP. The working height of the biofilter is determined in accordance with the required treatment efficiency. The temperature of sewage may be taken as equal to 8 - 10°C, while the permissible rate with respect to BOD_{20} per sq. meter of the biofilter is 1,700 gm/m^2/day.

The distribution of the liquid is best done mechanically by means of sprinklers driven by an electric motor. This reduces the hydraulic losses to 0.3 - 0.5 m (as compared with 1.2 - 1.5 m in the case of jet sprinklers).

The standard high-rate biofilters are round in plan view and have diameters ranging from 6 to 30 m. The depth of media is the same for the biofilters of all types, i.e. 4 and 2.3 m.

The biofilters recommended in this handbook are square in plan view, which simplifies their installation in buildings. However, this makes it difficult to sprinkle the corners of the biofilter and therefore it is essential to provide openings in the ends of the perforated sprinkler tubes. The biofilters are provided with artificial aeration, except where the media depth is 2 m only.

Secondary Settling Tank for the Biofilter connected with Primary Clarifier

There are two versions of the secondary settling tank. The first version is provided with a damping chamber in the center of the settling tank, which collects the liquid after filtration. This version is shown in the handbook. The collecting troughs are protected from the untreated waste water by a shield installed along the periphery of the settling tank.

The second version makes use of the principle of peripheral distribution of the liquid over the surface of the settling tank. The treated waste water is collected by a diffuser located in the centre, the top of which represents a number of spillways of triangular cross-sections. The part where settling takes place is separated from the diffuser by a so-called outlet chamber. This version is also shown in the handbook.

The design of settling tanks is given below. It should be noted that this is a preliminary design which will be corrected after tests under operational conditions.

The handbook also contains drawings of large settling tanks (8 x 8, 9 x 9 and 10 x 10 m). To reduce the height of the structures, the part where settling takes place is designed in the form of four sumps, each containing an independent silt pipe. The design of large settling tanks is similar to those above, however, the distance from the damping and the outlet chambers to the top of sumps must not be less than 0.5 - 0.6 m.

Design of Clarifiers

A. **Settling tank with a damping chamber**

1. The total area of the settling tank F_{tot} and its size have to be equal to those of the biofilter.

2. The settling tank is designed for the maximum hourly inflow of sewage with allowances for the recirculation of treated water:

$$q = q_{max} + q_p, \text{ m}^3/\text{sec}$$

where $q_p = Q_{av} \times n;$

q_p is the recirculation discharge; Q_{av} is the average daily inflow of sewage; n is the recirculation coefficient; q_{max} is the maximum sewage discharge per second;

q is the design discharge of sewage.

3. There should be at least two settling tanks if the daily inflow of sewage exceeds 300 m^3, and all of them must be operating.

4. The width of the deflecting shield $a_{щ}$ is determined in relation to the dimensions of the settling tank (for a daily sewage discharge of 200 - 300 litres per capita.

Side of Settling Tank in Plan View, m	Width of Deflecting Shield, m
4 - 5	1.0
6 - 7	1.0 - 1.5
8 - 10	1.5 - 2.0

5. The walls of the shield should be inclined at an angle of 15 - 20°. The smaller angle should be adopted in the case of larger settling tanks and vice versa.

6. The upper opening in the damping chamber in plan view (a_{BO}) must be 15 - 20 cm larger than the aperture in the deflecting shield (a_{np}) (measured along the water level).

7. The exit velocity of the liquid from the lower opening in the damping chamber V is taken as equal to 8 - 10 mm/sec. (as in the case of the flocculation chamber in a unit with natural aeration).

8. The average area of the damping chamber is equal to:

$$F_{av} = \frac{f_a + f_b}{2}, \text{ m}^2$$

where

f_a is the area of the upper opening determined as in point 6 above;

f_b is the area of the lower opening, equal to:

$$f_b = \frac{q}{V}, \text{ m}^2.$$

9. The area F_s where settling takes place will be:

$$F_s = F_{tot} - F_{av}, \text{ m}^2.$$

10. The velocity of liquid V_s in the settling section will be:

$$V_s = \frac{q}{F_s}, \text{ m/sec;}$$

this velocity must not exceed 0.5 mm/sec.

11. The height of the settling section h_o is found as follows:

$$h_o = V_s \times t, \text{ m},$$

where t is the time required for settling (1.5 hours).

12. The walls of the damping chamber should be inclined at an angle of at least 45°.

13. The distance between the upper level of the sludge and the lower opening in the damping chamber must be at least 0.6 m.

14. The walls of the bottom of the settling section should be inclined at an angle of at least 50°.

B. **Settling tank with an outlet chamber**

The design of this tank is as follows:

1. The area of the upper opening in the chamber f_a is:

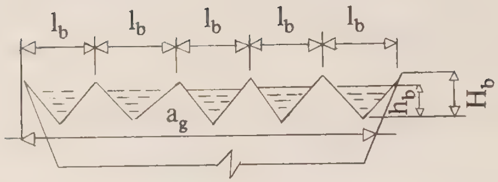
$$f_a = f_g + f_c$$

f_c is the area of the inflowing part of the upper opening;

f_g is the area of the diffuser for the collection of treated water.

2. The device for the collection of purified water represents a diffusor with triangular spillways along its perimeter (see Figure below).

Figure



3. The area of the diffuser f_g is found as bellows:

$$f_g = a_g^2, \, m^2;$$

$$a_g = \frac{n}{4} \times l_b, \, m;$$

$$l_b = 2H_b, \, m;$$

$$H_b = 1.3 \times h_b, \, m \text{ (according to design)};$$

$$n = \frac{q}{q_{eg}};$$

$$q_{eg} = 1.4 \times h_b^{5/2}, \, m^3/sec,$$

where

a_g is the side of the diffuser;

l_b is the length of one spillway;

H_b is the height of the spillway;

h_b is the pressure on the spillway;

n is the number of spillways;

q_{eg} is the sewage discharge through one spillway.

4. The area of the outflowing part of the upper opening (between the diffuser and the walls of the chamber) (fd) is found from the rate of flow of the liquid V equal to 8 – 10 mm/sec.

$$f_d = \frac{q}{V}, \, m^2.$$

5. The area of the lower opening in the chamber at V = 2 – 2.5 mm/sec. will be:

$$f_e = \frac{q}{V}, \, m^2.$$

6. The average area of the outlet chamber is as follows:

$$F_{av} = \frac{f_d + f_e}{2}, \, m^2.$$

7. The rate of flow in the settling section and the height of the chamber are found as in the preceding action.

8. The walls of the chamber should be inclined at an angle of at least 45°.

9. The amount of sediment, the design of the bottom, and other parameters of the settling tank are determined as outlined in SNiP

The Layout of Structures at Sewage Treatment Plants

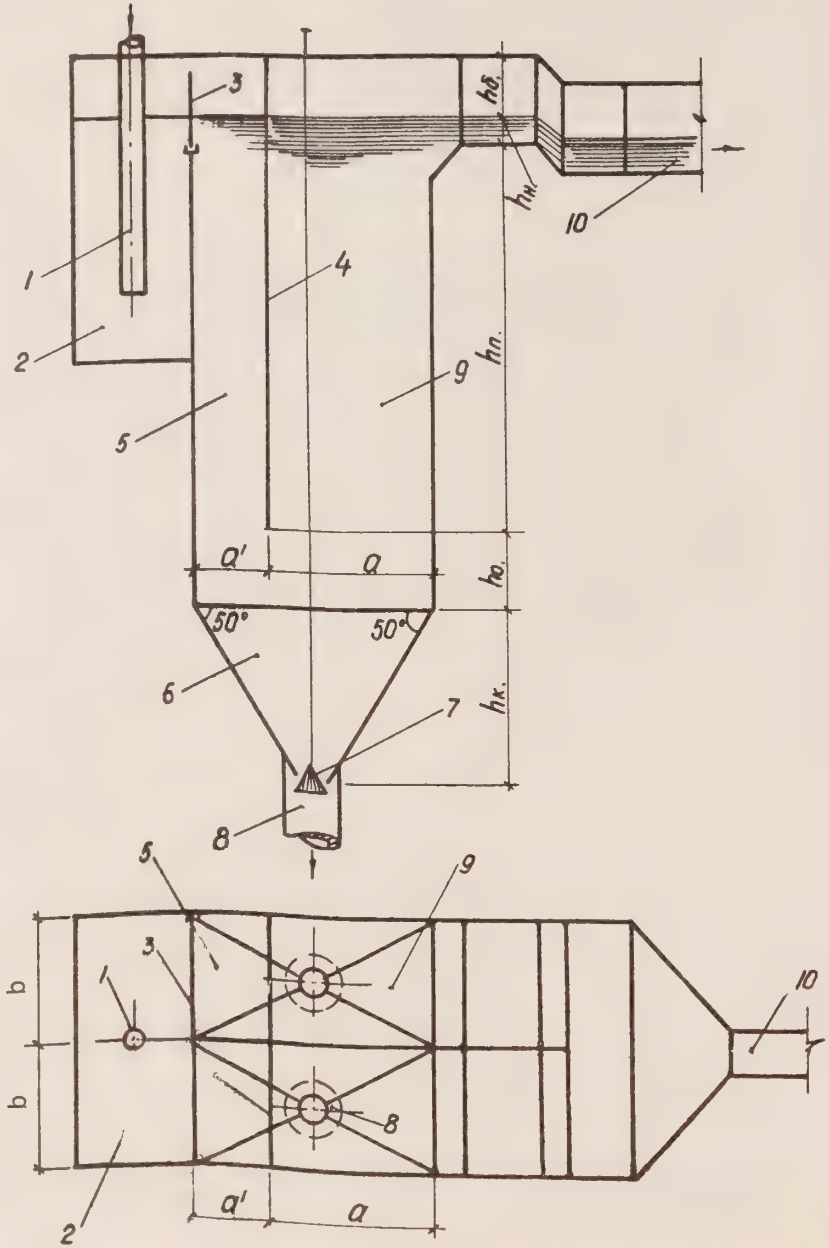
The vertical layout of structures is shown in the handbook. The elevations shown in the layout will be the same for plants of any capacity. The actual height of structures will depend on the dimensions of their conical part. The determining factor is the height of the secondary settling tank.

The layout includes provision for disinfection of purified liquid with calcium hypochlorite. This is done by means of a mixer and a contact reservoir designed by conventional methods as outlined in SNiP.

The structures may be located partly below the surface of the ground in cases where this is possible. The tentative ground surface is shown on the vertical layout by a dotted line. In the case of buildings with a ventilated crawl space, all structures are installed within the building. The tentative floor level on the first storey is shown on the layout by a continuous line.

The sludge is transported from the clarifier and the digester by a pump which also serves as a means for mixing the sludge in the digester. It is expedient to direct the sludge from the secondary settling tank to the receiving reservoir. If required the treated water should be directed there also for further circulation. The sludge from the contact reservoir should be transported to the disposal areas or to a special reservoir (in exceptional cases).

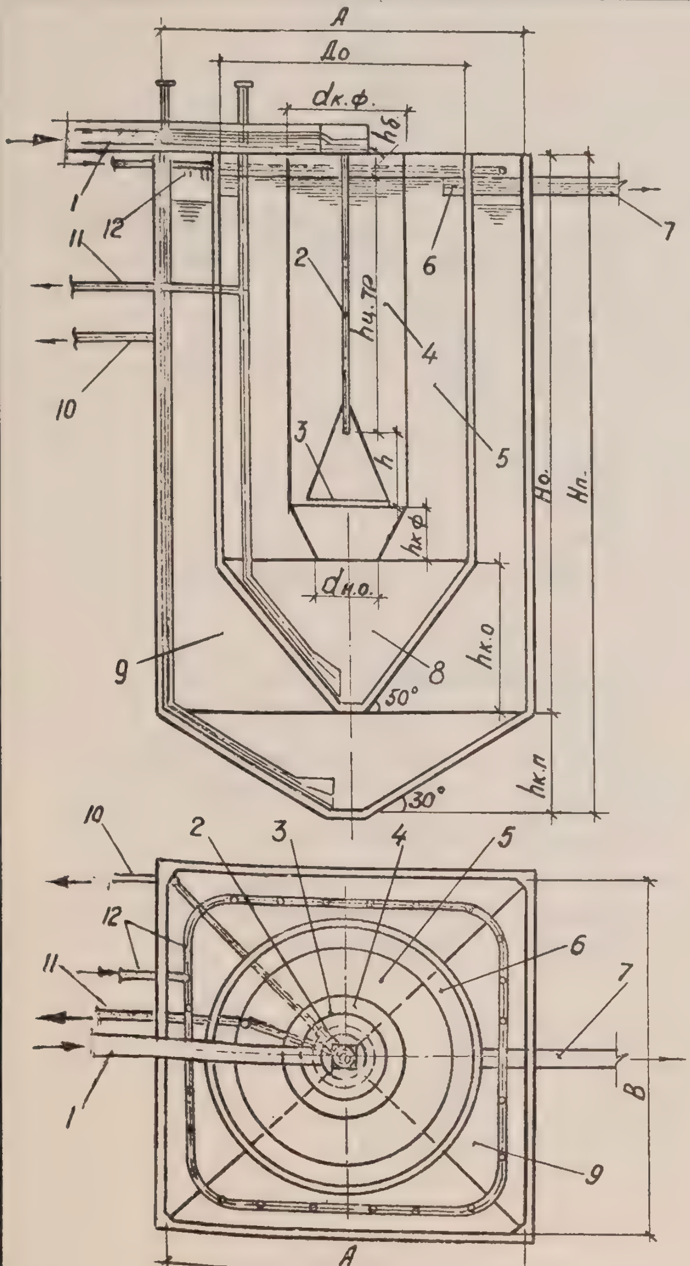
The handbook shows also the approximate layout of a sewage treatment plant with a capacity of 600 – 700 m^3/day. The plant is located in a building with a ventilated crawl space. The height of the biofilters in 4 m. The height of the building (from the first storey floor to the roof truss) is 12.6 m. This layout shows that the recommended structures allow the structural volume of the building to be reduced by a factor of at least 1.5 as compared with standard designs.



1. inflow forcemain;
2. surge tank;
3. gate valves;
4. partition wall;
5. influent chamber;
6. settling cone;
7. mechanical valve;
8. sand withdrawal;
9. settling chamber;
10. outlet channel;

$h_в$ height of unfilled section;
h_H liquid level;
$h_п$ height of partition wall in settling chamber;
$h_о$ height of inlet channel;
$h_к$ height of settling cone;
a' length of influent chamber;
a length of settling chamber;
b width of one section.

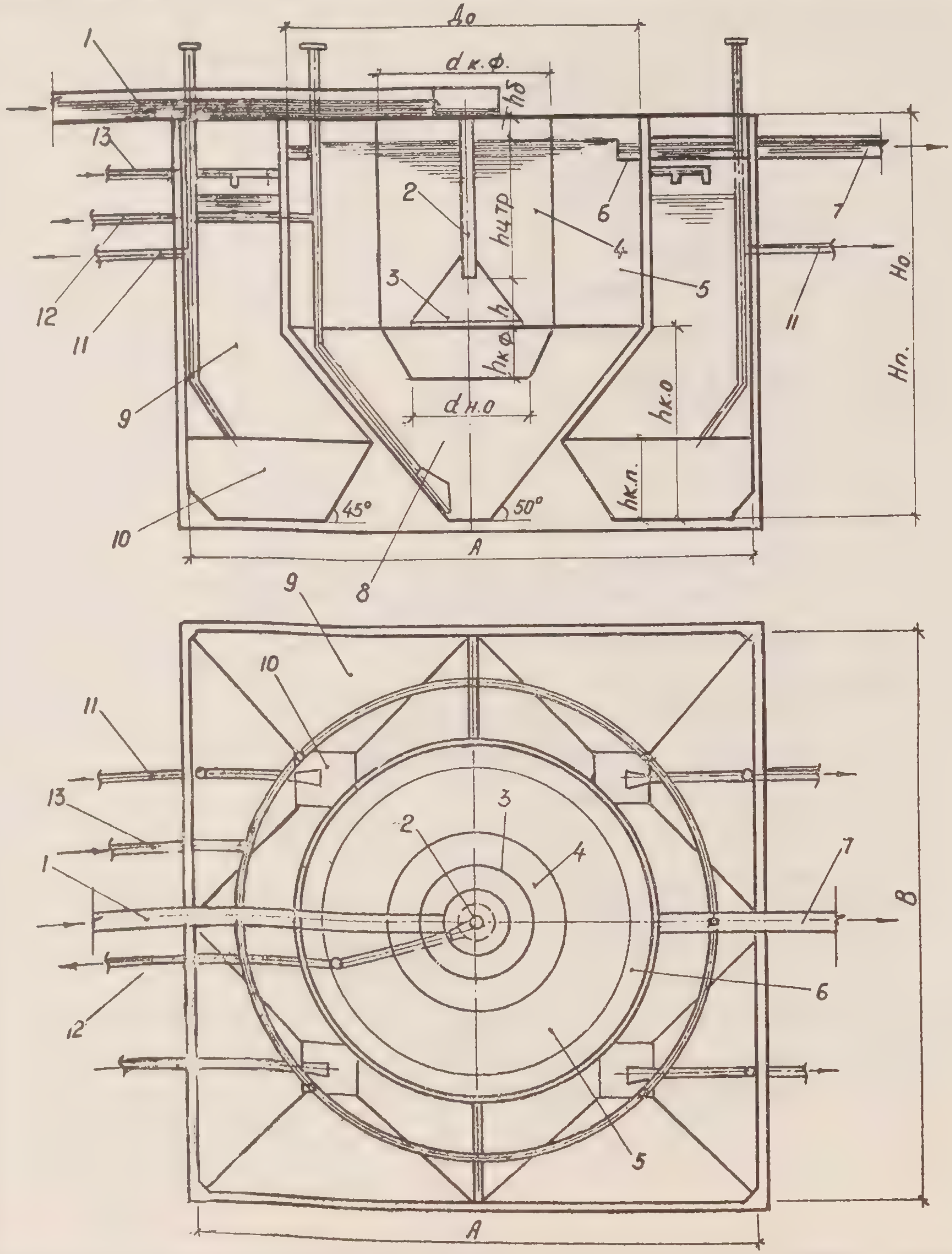
Clarifier - digestor (with biofilter)	VI — 2



1 – sewage inflow channel;
2 – feed pipe;
3 – deflecting shield;
4 – flocculation chamber;
5 – settling section of clarifier;
6 – collecting trough;
7 – outlet channel;
8 – settling section of clarifier;
9 – digestor;
10 – pipe for digested sludge;
11 – pipe for raw sludge;
12 – pipe for sludge dosing to the digestor;
$h_{\text{б}}$. – height of unfilled section;
$h_{\text{ц.тр}}$.– height of feed pipe;
h – gap between the shield and the feed pipe;
$h_{\text{к.ф}}$.– height of cone of the flocculation chamber;
$d_{\text{н.о}}$.– diameter of lower opening;
$d_{\text{к.ф}}$.– diameter of flocculation chamber;
$h_{\text{к.о}}$.– height of conical part of clarifier;
$Д_{\text{о}}$. – diameter of clarifier;
$h_{\text{к.п}}$ – height of conical part of digestion chamber;
$H_{\text{о}}$. – height of clarifier;
$H_{\text{п}}$. – height of digestor;
A – length of clarifier-digestor;
B – width of clarifier-digestor.

Clarifier - digestor (with aeration tank)

VI – 3

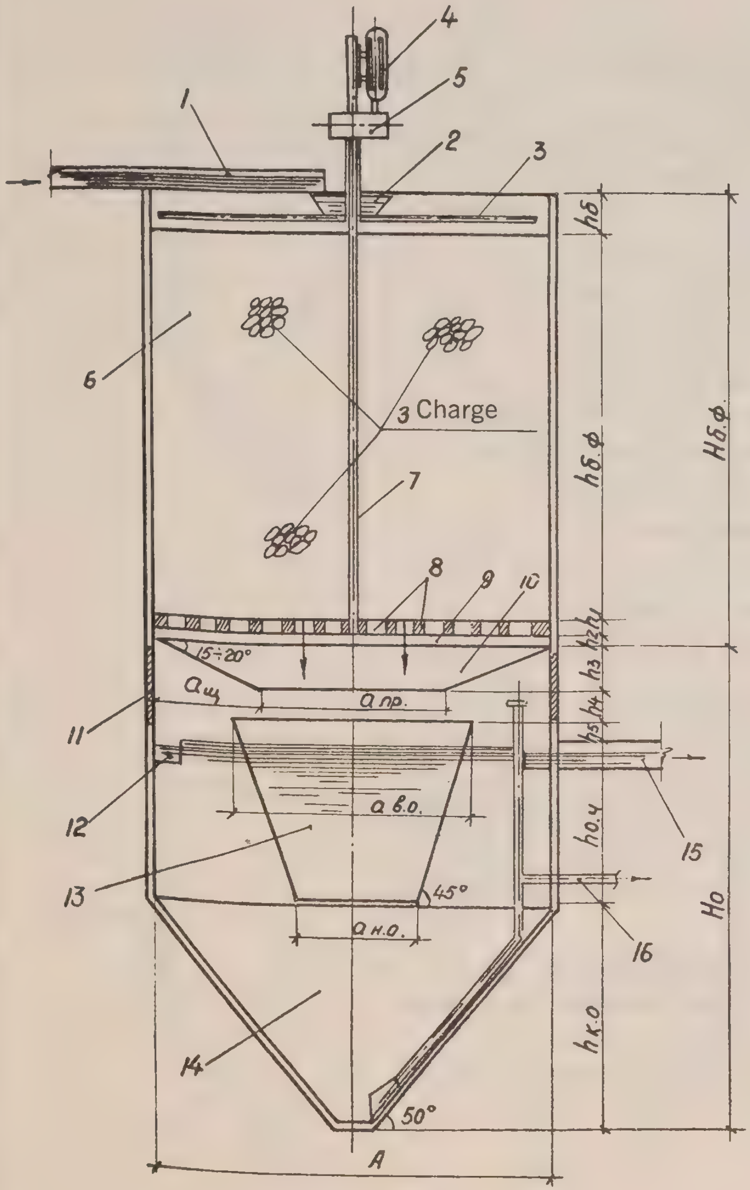


1 – inflow channel;
2 – feed pipe;
3 – deflecting shield;
4 – flocculation chamber;
5 – settling section of clarifier;
6 – collecting trough;
7 – outlet channel;
8 – settling section of clarifier;
9 – digestor;
10 – sump;
11, 12, 13 – pipelines for raw and digested sludge;

$h_{б.}$ – height of unfilled section;
$h_{ц.т.р}$ – height of feed pipe;
h – gap between the shield and pipe;
$h_{к.ф.}$ – height of cone of the flocculation chamber;

$d_{н.о.}$ – diameter of lower opening;
$d_{к.ф.}$ – diameter of flocculation chamber;
$h_{к.о.}$ – height of conical part of clarifier;
$Д_{о.}$ – diameter of clarifier;

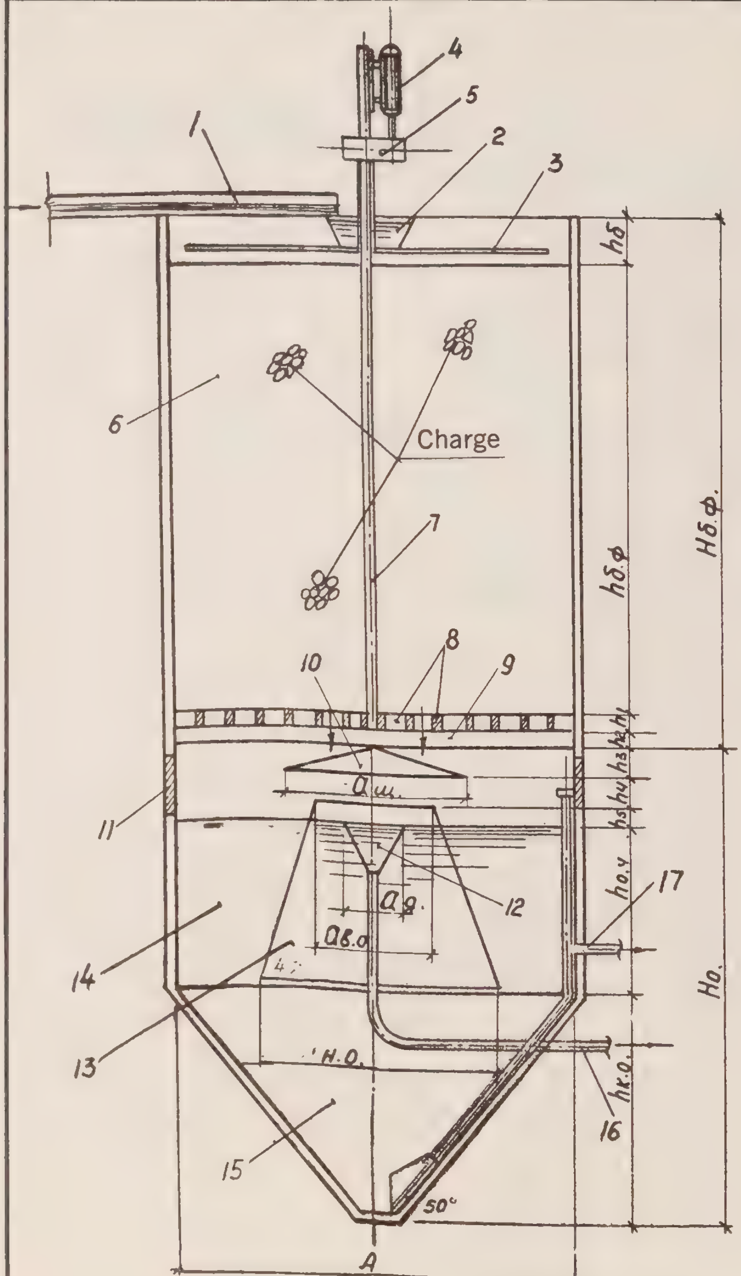
$h_{к.п.}$ – height of sump;
$H_{о.}\ H_{п.}$ – height of clarifier-digestor;
A – length of digestor;
B – width of digestor.



1 – influent channel;
2 – distributor;
3 – sprinkler;
4 – electric motor;
5 – gear;
6 – high-rate biofilter;
7 – sprinkler support;
8, 9, – bottom of biofilter;
10 – deflecting shield;
11 – openings for assembly work;
12 – collecting trough;
13 – settling chamber;
14 – settling section;
15 – outlet channel;
16 – pipe for the discharge of biofilm;
$h_{\text{б}}$ – height of unfilled section;
$h_{\text{б.ф}}$ – height of biofilter charge;
$h_{\text{о.ч}}$ – height of settling section;
$h_{\text{к.о}}$ – height of conical part of settling tank;
$H_{\text{б.ф}}$ – height of biofilter;
$H_{\text{о}}$ – height of secondary settling tank;
$a_{\text{пр}}$ – width of opening in the deflecting shield;
$a_{\text{в.о}}, a_{\text{н.о}}$ – dimensions of settling chamber;
A – length of biofilter;
$a_{\text{щ}}$ – width of deflecting shield;
h_1, h_2, h_3, h_4, h_5 – structural heights.

Biofilter - settling tank (with outlet chamber)

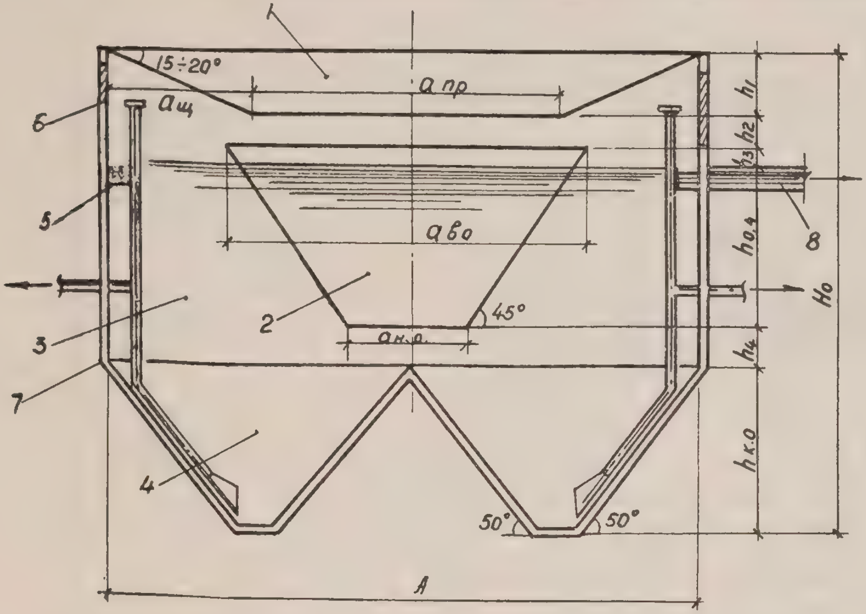
VI – 5

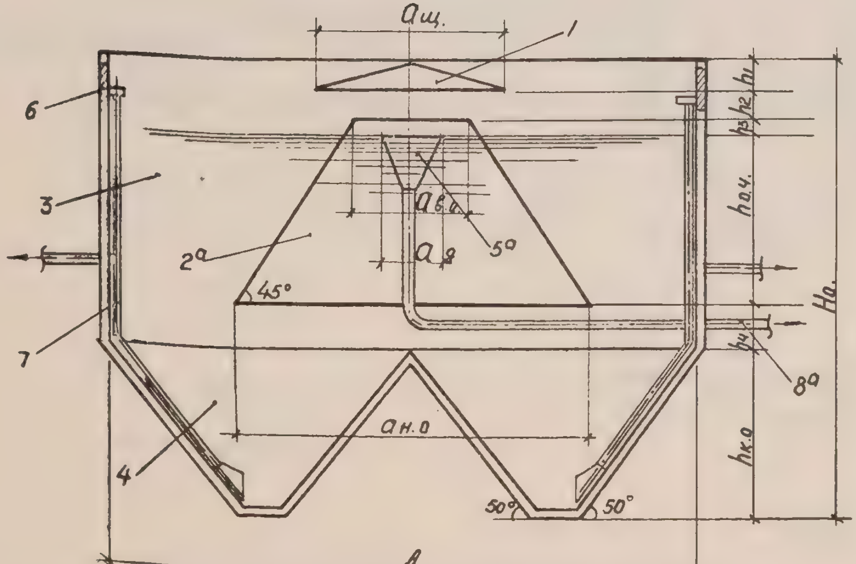


1 – influent channel;
2 – distributor;
3 – sprinkler;
4 – electric motor;
5 – gear;
6 – high-rate biofilter;
7 – sprinkler support;
8, 9 – bottom of biofilter;
10 – deflecting shield;
11 – openings for assembly work;
12 – diffusor for collecting water;
13 – outlet chamber;
14 – settling section;
15 – sedimentary section;
16 – pipe for treated water;
17 – pipe for the discharge of biofilm;

$h_{б.}$ – height of unfilled section;
$h_{б.ф.}$ – height of biofilter charge;
$h_{о.ч.}$ – height of settling section;
$h_{к.о.}$ – height of conical part of settling tank;
$H_{б.ф.}$ – height of biofilter;
$H_{о}$ – height of secondary settling tank;

$a_{д.}$ – width of diffusor;
$a_{в.о}, a_{н.о.}$ – dimensions of settling chamber;
A – length of biofilter;
h_1, h_2, h_3, h_4, h_5 – structural heights.





1 – deflecting shield;

2 – damping chamber;

2^a – outlet chamber;

3 – settling section;

4 – sump;

5 – collecting trough;

5^a – diffusor for collecting water;

6 – access openings;

7 – pipe for excess biofilm;

8 – outlet channel;

8^a – pipe for treated water;

$h_{\text{о.ч.}}$ – height of settling section;

h_4 – gap between the chamber and the settling section;

$h_{\text{к.о.}}$ – height of settling section;

$a_{\text{пр}}$ – width of opening in deflecting shield;

$a_{\text{в.о}}, a_{\text{н.о.}}$ – dimensions of damping and outlet chambers;

$a_{\text{щ}}$ – width of deflecting shield;

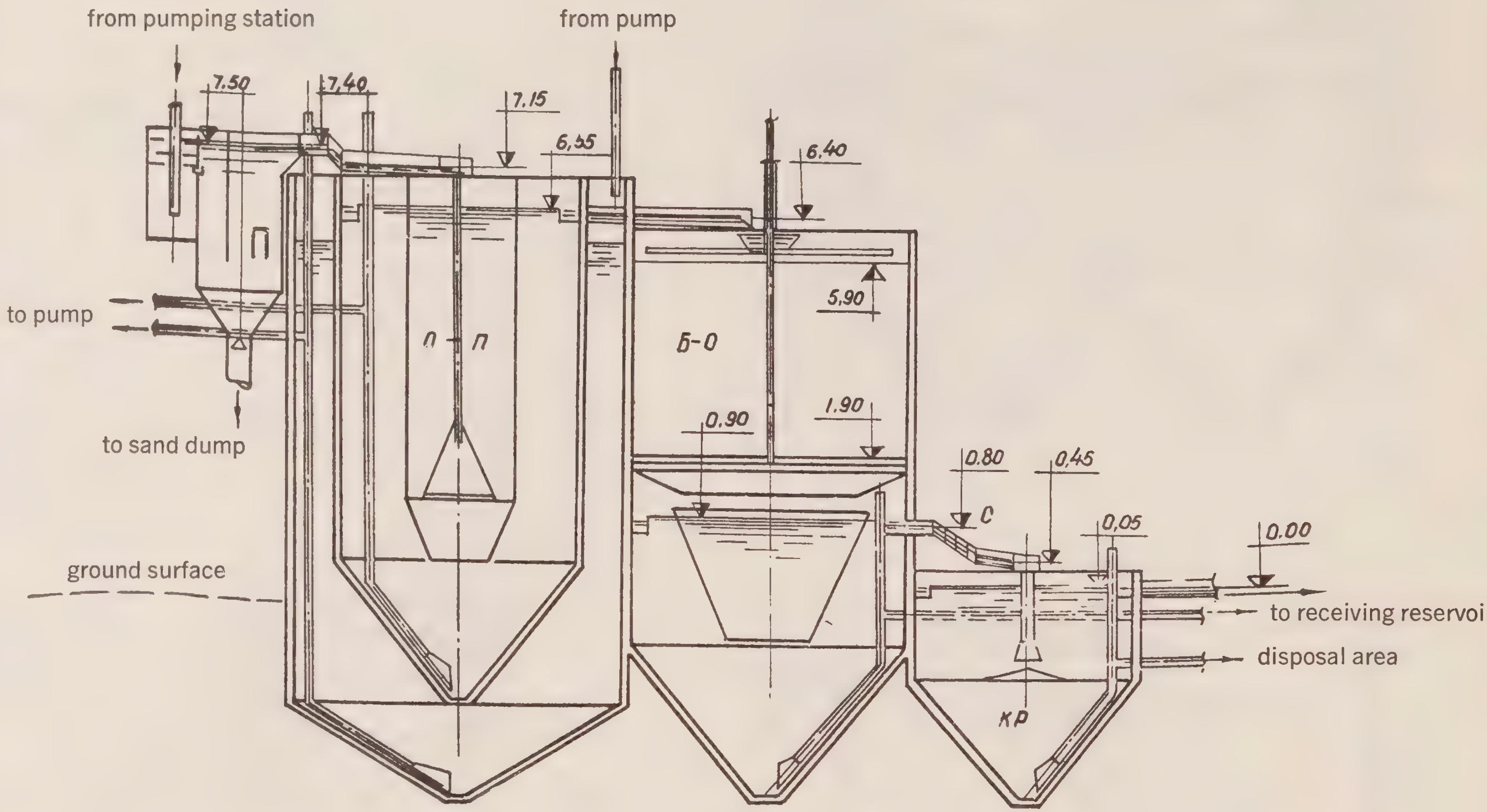
$a_{\text{д}}$ – width of diffusor;

h_1, h_2, h_3 – design heights;

H_0 – height of settling tank;

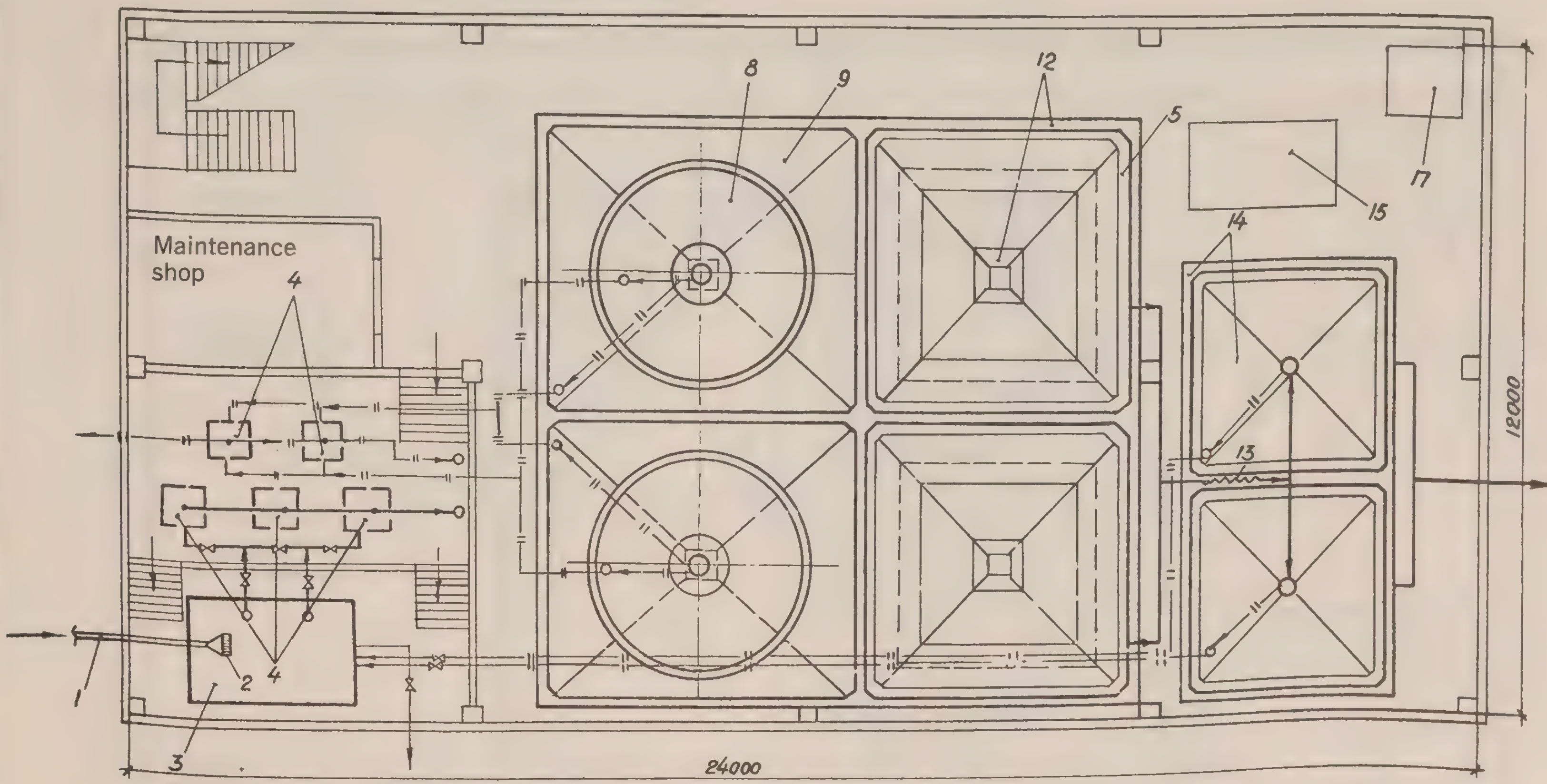
A – length of settling tank.

Vertical layout of sewage treatment structures	VI – 7



П – sand trap with damping chamber;
О-П – clarifier-digestor;
Б-О biofilter;
С – mixer;
КР – contact reservoir.

Sewage treatment plant with an output of 600 - 700 m³/day. Plan of first floor (elevation 1.5 m)	VI – 8



emergency discharge

1 – influent sewer

2 – baffle

3 – inlet reservoir

4 – pumps

5 – troughs

8 – clarifier

9 – digestor

12 – settling tank

13 – mixer

14 – contact reservoir

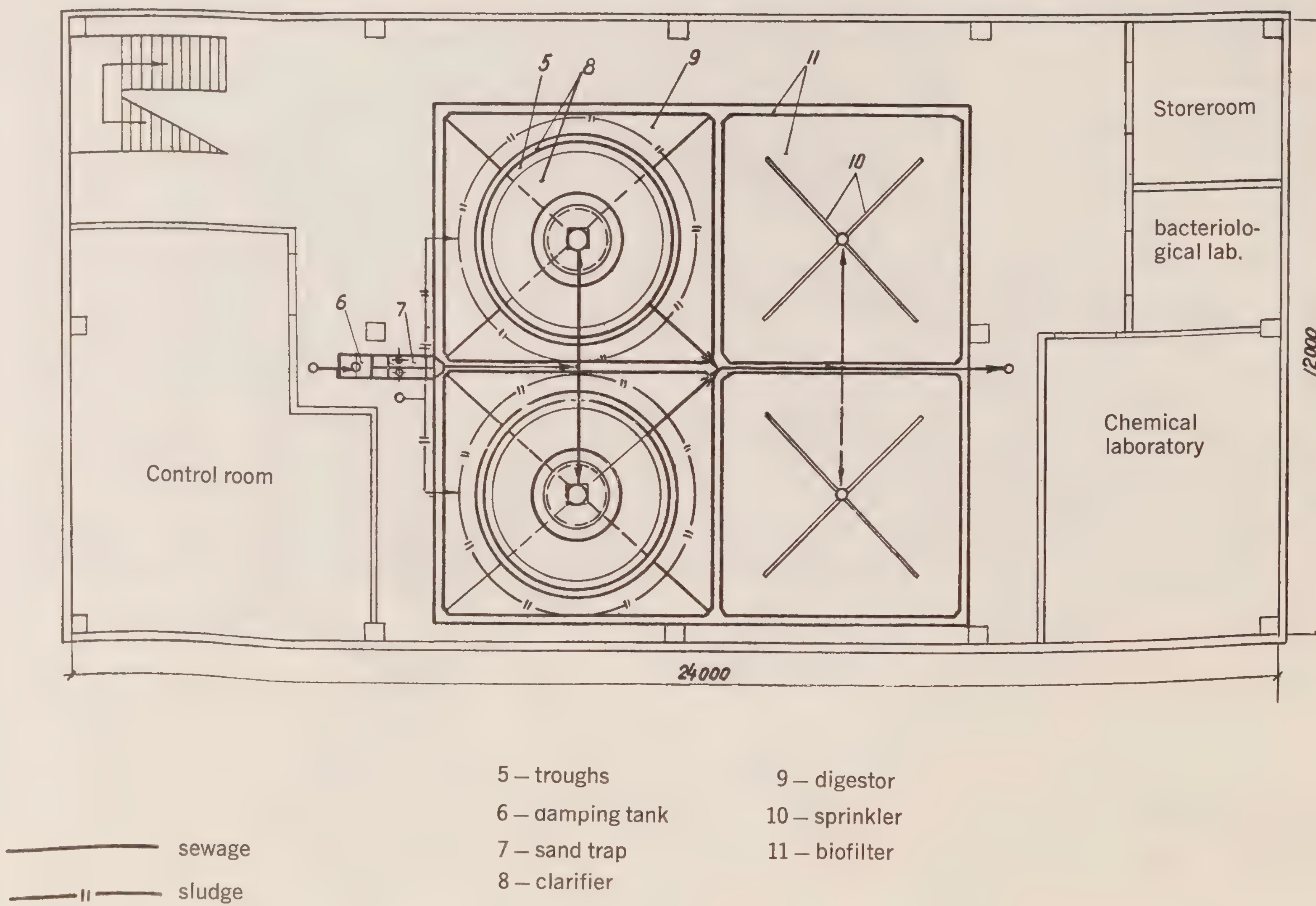
15 – biofilter fans

17 – hoist

sewage

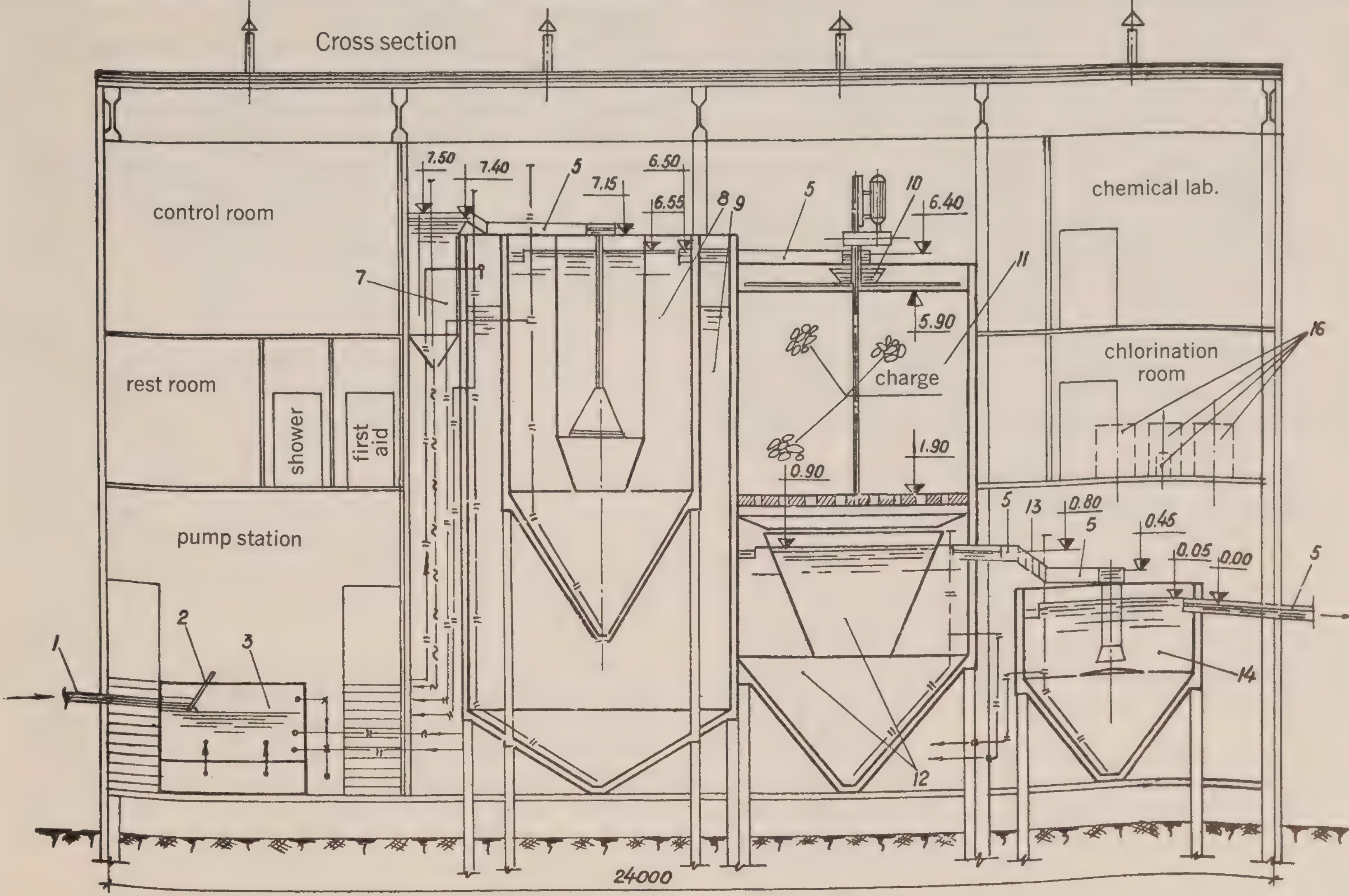
sludge

Sewage treatment plant with an output of 600 - 700 m^3/day. Plan of 4th floor (elevation 7.5 m)	VI – 9



5 – troughs
6 – damping tank
7 – sand trap
8 – clarifier
9 – digestor
10 – sprinkler
11 – biofilter

Sewage treatment plant with an output of 600 - 700 m^3/day.	VI — 10



sewage
grit
sludge

16. solution and distribution tanks;
other symbols as before (see text)

Non-freezing water supply equipment

Standard fittings are unsuitable for open and enclosed water supply systems operating under severe climatic conditions in the Far North.

The non-freezing fittings designed and fabricated in Noril'sk are simple to use and give reliable performance at low air and water temperatures. The designs of these fittings are based on the following principles:

a) the fittings must not be heated externally (in heated rooms), use should be made of heat of water in the pipeline;

b) the valves should be located in the water, or as close as possible to the pipeline, so that water under the valve will not freeze;

c) the water above the valve (in the direction of flow) must be automatically discharged after each shut-off;

d) the surface area of fittings exposed to the air must be small;

e) the fittings must be free of dead-ends in which water may freeze;

f) the valves must be self-sealing.

The handbook contains basic non-freezing equipment used in operating water supply systems in Noril'sk and other cities in the Far North.

The plunger type hydrant designed by A.A. Vershinin is used on surface pipelines. The valve in the hydrant is sealed by the diaphragm pressing on the cylindrical surface of the plunger and by the head of the plunger pressing on the diaphragm. For the first time in water supply engineering the closing function is performed by a plunger moving in an opening in the elastic diaphragm. The hydrant does not require a gasket.

The hydrant for a surface system designed by G.I. Pigushin has a valve of a plunger type. The hydrant is mounted on the pipe. Its drawback is the fact that remaining water is ejected after each use. Therefore it cannot be installed in manholes in a buried system.

The hydrant designed by V.A. Kudoyarov and N.S. Medvedev combines the positive aspects of both the plunger hydrant and that of the Moscow type. The hydrant may be used in both buried and surface systems. It may be installed without a well. Its design prevents the contamination of the pipeline. If the pipe diameter is relatively small, a large diameter notch is made at the hydrant connection.

The fire hydrant designed by B.V. Doroshevskii was later modified by A.A. Vershinin who replaced the gaskets by a rubber diaphragm. The packing of the spindle suggested by Vershinin is now used in all types of non-freezing fittings. The Doroshevskii hydrant has no riser and is mounted directly on the pipe. It is simple and convenient for use in surface systems, but is not suitable for buried systems (in conduits and manholes).

The fire hydrant for buried systems designed by A.V. Lyutov performs well in the Far North. It can be turned on quickly and does not require a stand. The small screw pitch of the spindle allows the valve to close smoothly without hydraulic shocks.

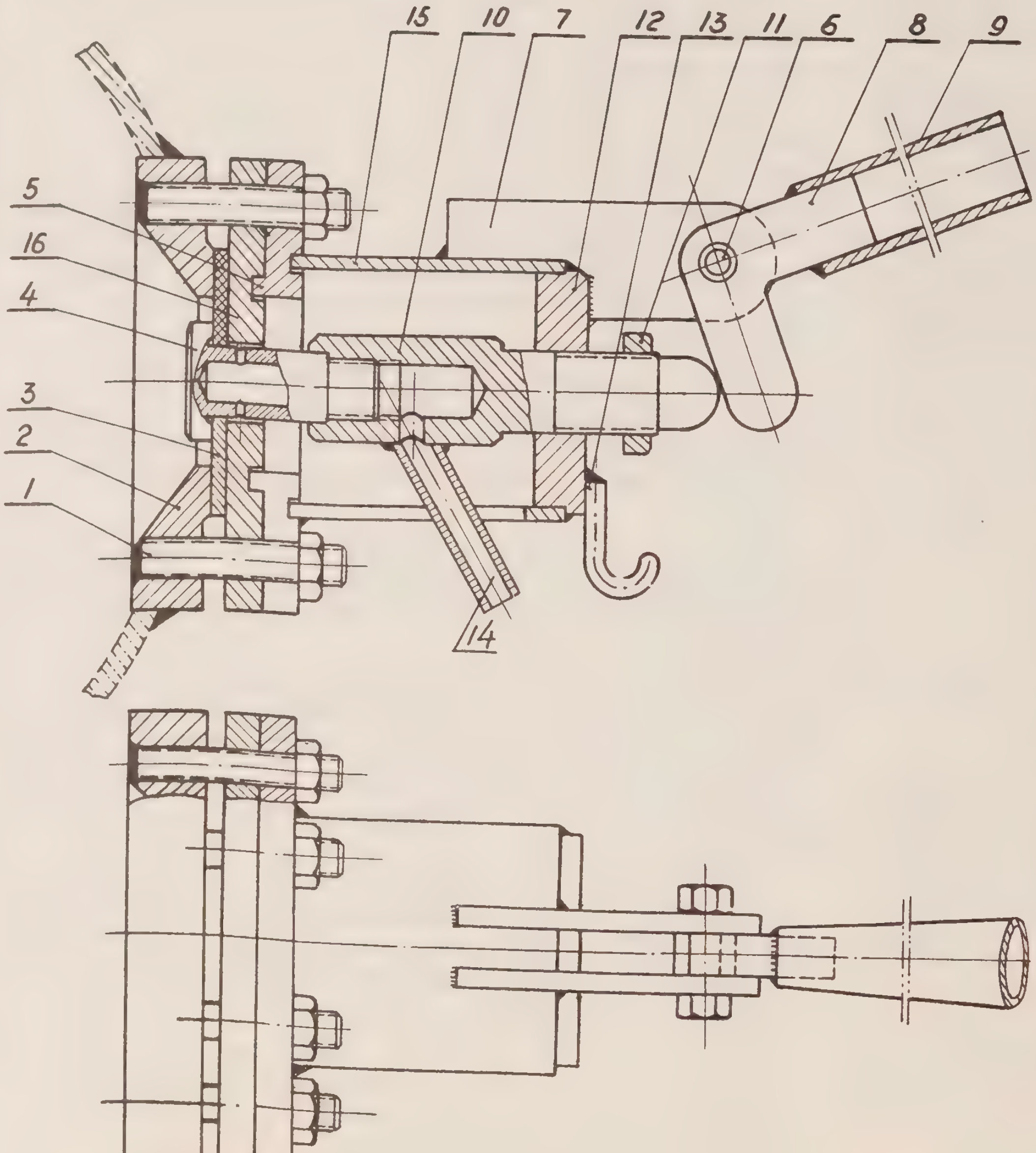
The water outlet developed at the A.P. Zavenyagin mining and metallurgical combine in Noril'sk permits water pipes and water supply systems to be drained under severe climatic conditions.

The gasket expansion joints freeze up under operating conditions in the Far North, thus causing pipe rupture and large-scale breakdowns. The self-sealing expansion joint designed by A.V. Lyutov does not freeze up and is simple and reliable. It requires 2 – 3 times less metal than a gasket expansion joint.

The air vent with a damper designed by V.A. Kudoyarov automatically protects the pipes from failure due to atmospheric pressure, lets the air in on emptying the pipe, and lets it out on filling the pipeline. The handbook shows an air vent for large diameter pipes (800 mm and over).

The non-freezing manometer stand designed by A.V. Lyutov and A.A. Vershinin permits the pipe pressure to be measured in winter in the open air. The manometer may be changed without shutting off the pipeline.

Plunger type hydrant (designed by A. A. Vershinin) VII — 1

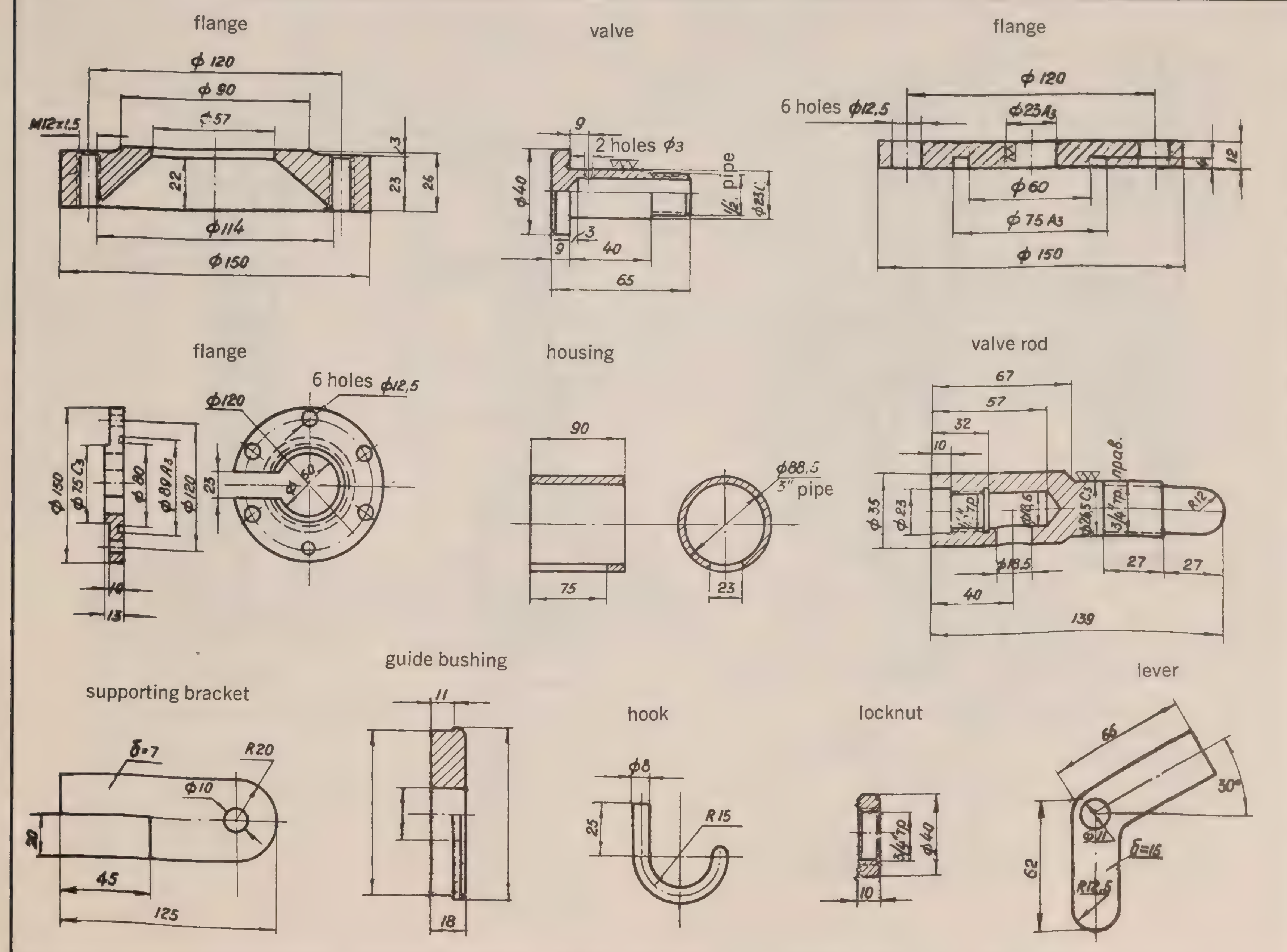


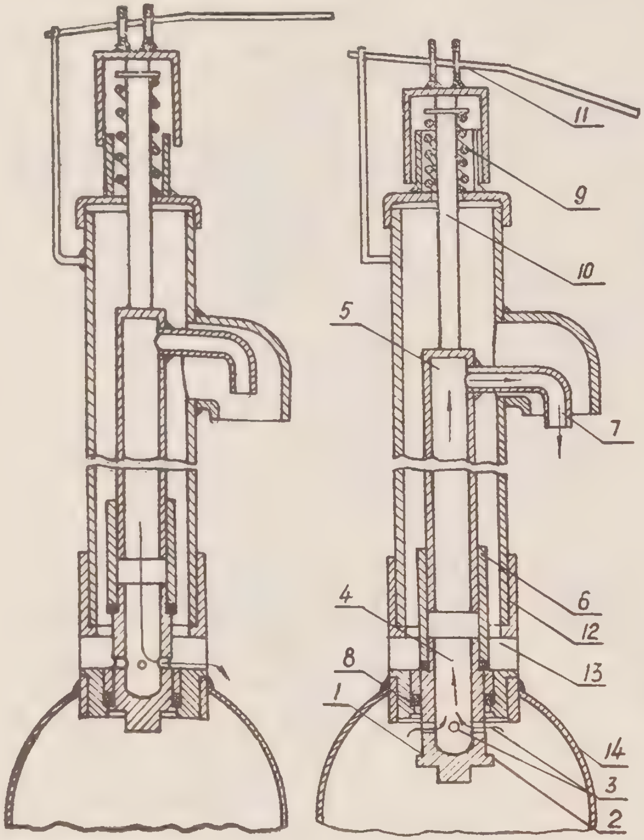
1. The hydrant is welded to the side of a pipe.
2. At the time of welding the rubber packing should be removed.
3. The hole for the plunger is made in the packing with a calibrated punch.

No.	Item	Material	Number
1.	Bolt M 12 x 55	Steel	6
2.	Flange	Steel	1
3.	Packing ø 90 x 23, $\delta = 6$	Rubber	1
4.	Valve	Stainless st., brass	1
5.	Flange	Steel	1
6.	Bolt M 10 1 = 44	Steel	1
7.	Supporting bracket	Steel	2
8.	Lever	Steel	1
9.	Pipe ø 1/2	Steel	1
10.	Valve rod	Steel	1
11.	Locknut	Steel	1
12.	Guide bushing	Steel	1
13.	Hook	Steel	1
14.	Pipe connection ø ½″ 1=60″	Steel	1
15.	Housing	Steel	1
16.	Flange	Steel	1

Plunger-type hydrant. Details

VII – 2

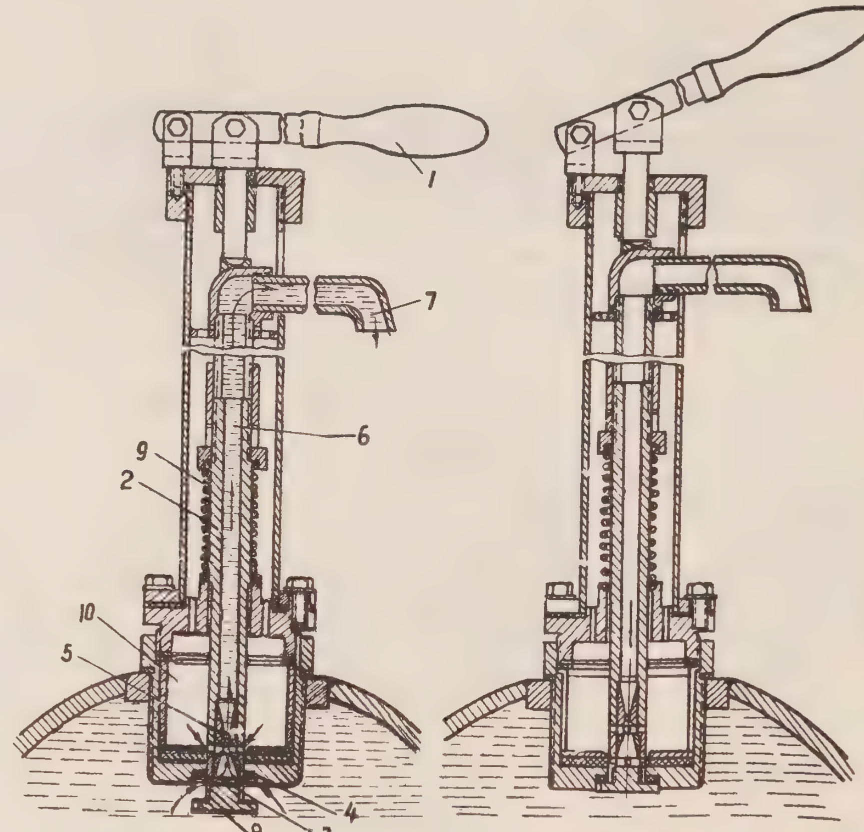




closed open

Hydrant designed by Pigushin

1. plunger
2. valve
3. entrance openings
4. internal space
5. supply pipe
6. socket
7. branch pipe
8. leather packing
9. spring
10. rod
11. lever
12. hydrant housing
13. discharge openings
14. water main

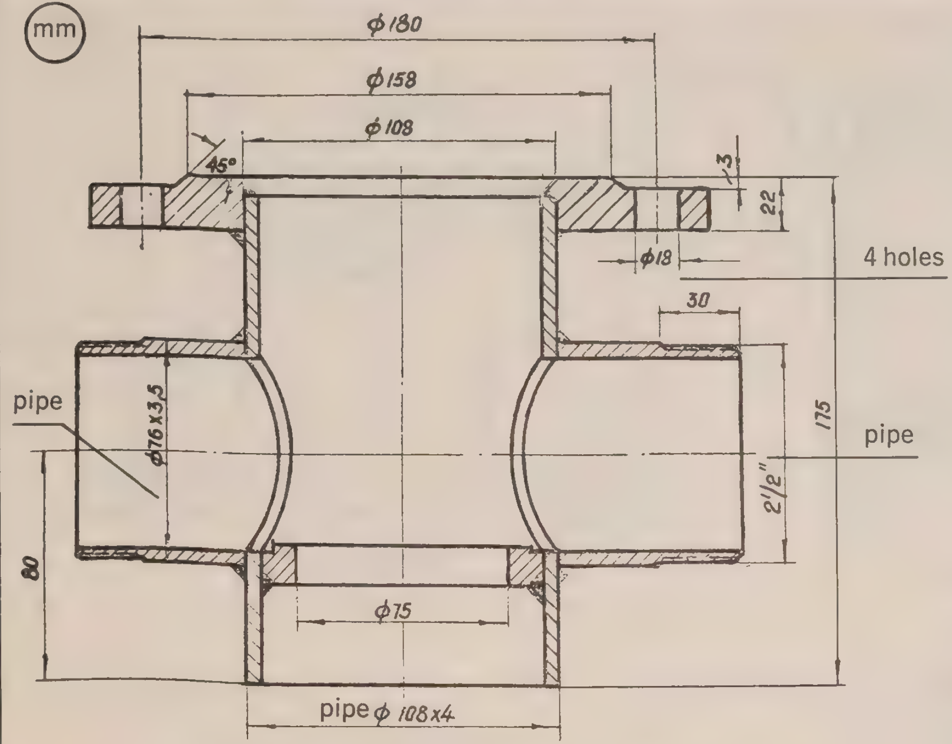


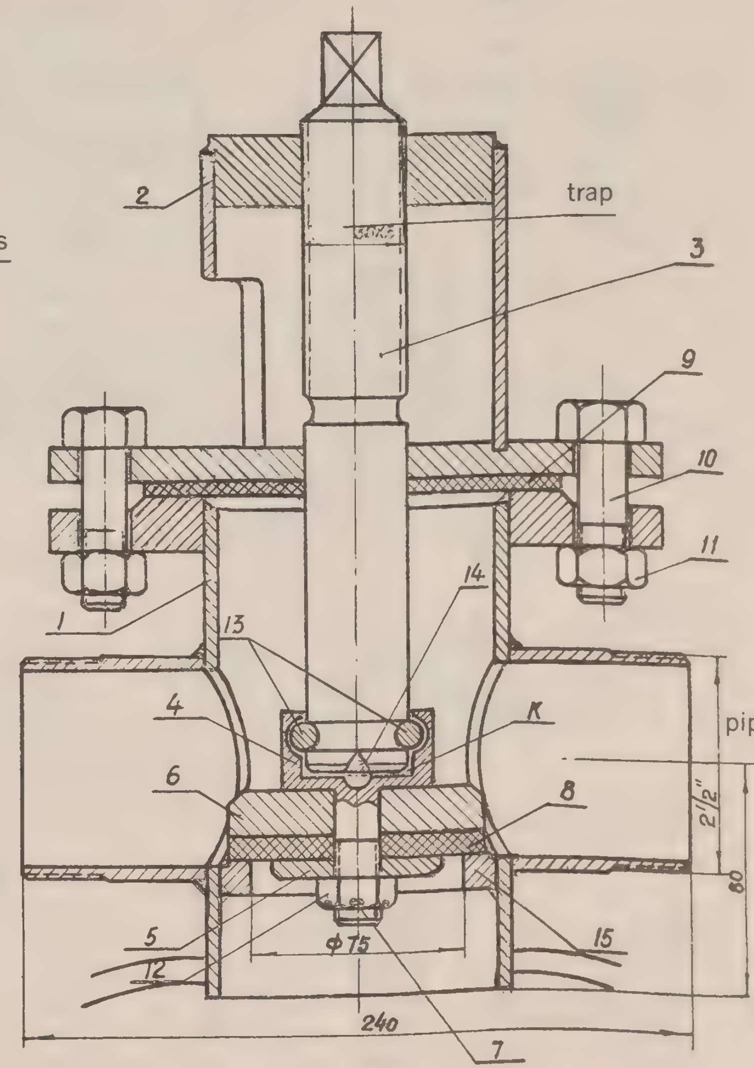
open closed

Hydrant designed by Kudoyarov and Medvedev

1. handle
2. riser
3. entrance openings
4. packing ring
5. ejector
6. riser pipe
7. discharge pipe
8. valve
9. spring
10. water chamber

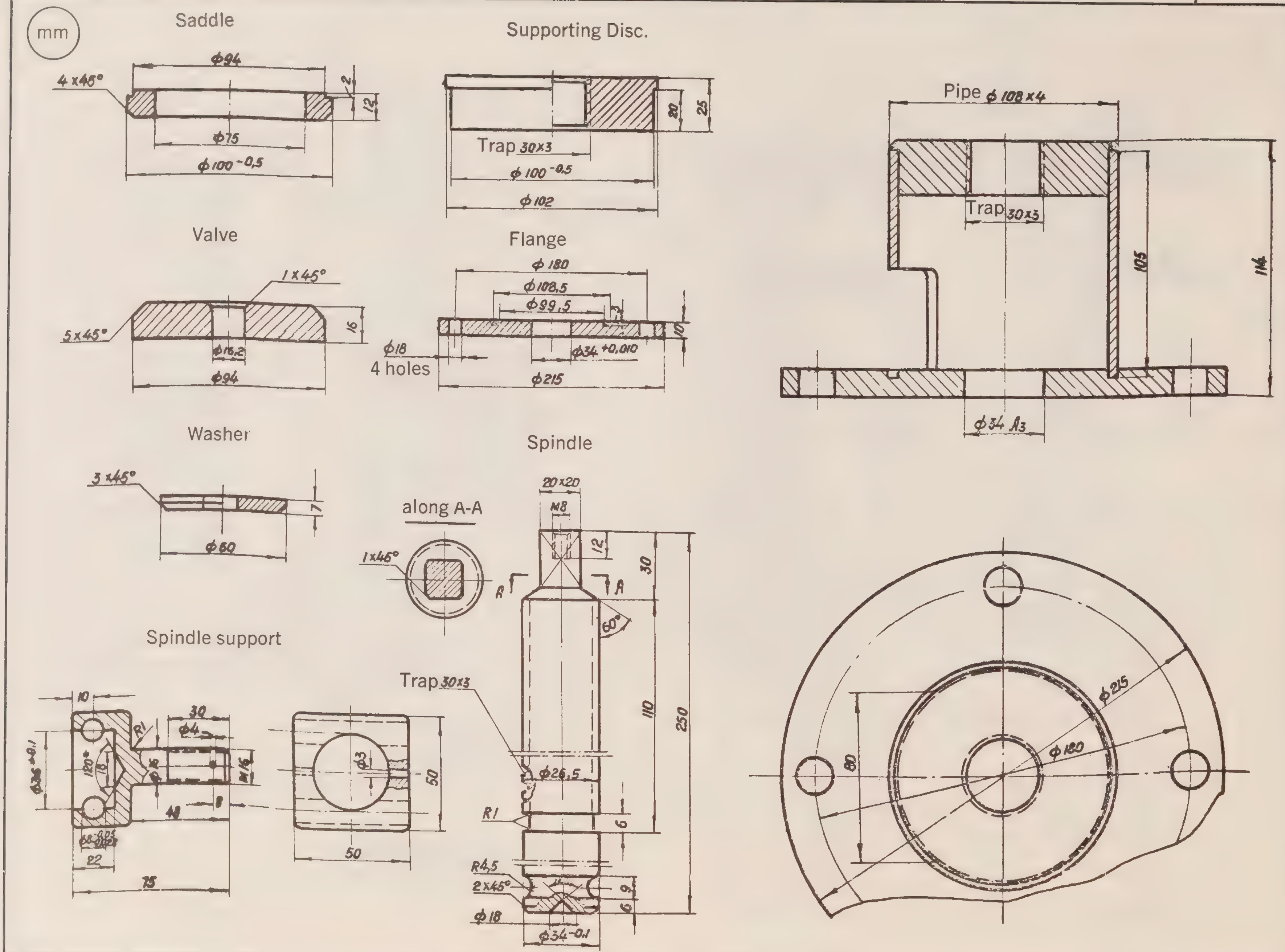
Fire hydrant (designed by B. V. Doroshevskii)





	Item	Number	Material
1.	Housing	1	Steel 3
2.	Cover	1	Steel 3
3.	Spindle	1	Stainless steel
4.	Spindle support	1	Steel 3
5.	Washer	1	Steel 3
6.	Valve	1	Steel 3
7.	Pin	2	Steel 3
8.	Packing $\delta = 8$	1	Rubber
9.	Packing $\delta = 6$	1	Rubber
10.	Bolt	4	Steel
11.	Nut	4	Steel
12.	Slotted nut	1	Steel
13.	Locking pin	2	Steel
14.	Ball	1	Stainless steel
15.	Saddle	1	Stainless steel

Note. On assembly the space marked K should be filled with grease.

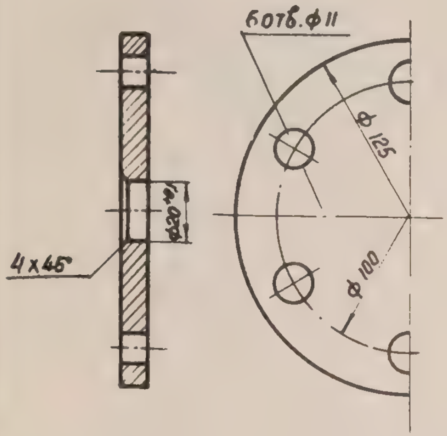

mm
Saddle
4 x 45°
ϕ94
2
12
ϕ75
ϕ100 -0,5
Supporting Disc.
Trap 30x3
ϕ 100 -0,5
ϕ 102
20
25
Pipe ϕ 108 x 4
Trap 30x3
105
114
ϕ34 A3
Valve
1 x 45°
5 x 45°
16
ϕ16,2
ϕ94
Flange
ϕ 180
ϕ108,5
ϕ99,5
10
ϕ18
4 holes
ϕ34 +0,010
ϕ215
Washer
3 x 45°
7
ϕ60
Spindle
20x20
M8
12
30
along A-A
1x45°
A
60°
Trap 30x3
ϕ26,5
110
250
R1
6
R4,5
2 x 45°
ϕ18
ϕ34 -0,1
Spindle support
10
30
R1
ϕ4
M16
8
22
75
50
50
ϕ 215
ϕ 120
80

Fire hydrant for buried water supply systems (designed by A. V. Lyutov)

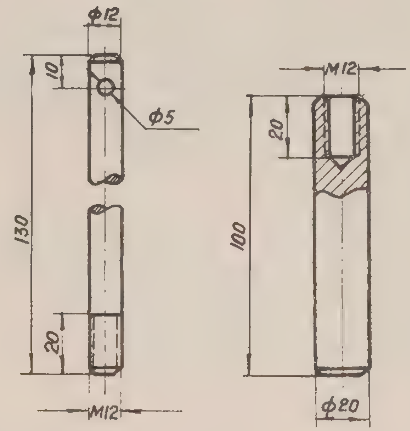
VII – 6

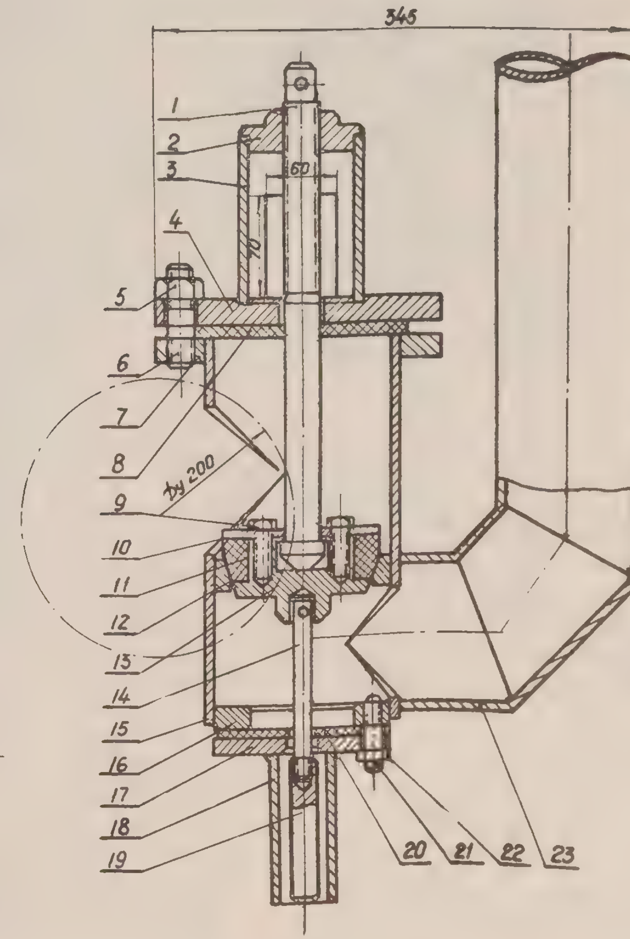
mm

Flange

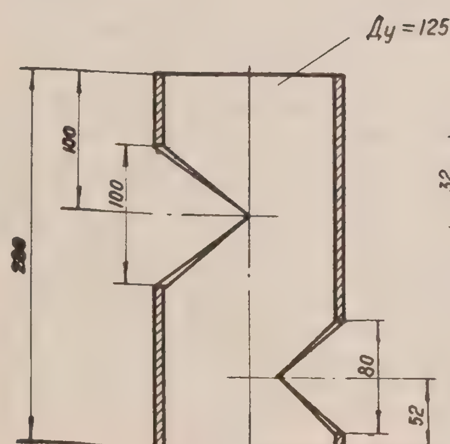


Pin and plunger

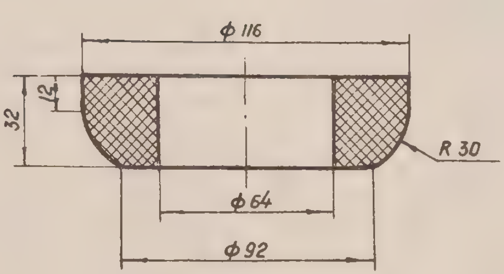




Housing



Sealing ring



For details see next page

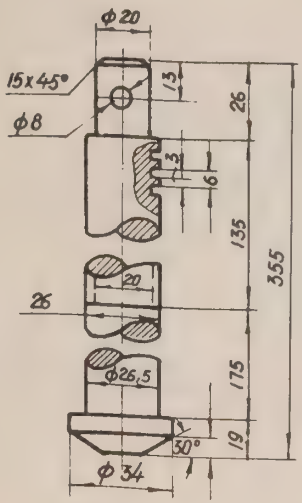
	Item	Number	Material
1.	Spindle	1	Stainless steel
2.	Nut	1	Steel 3
3.	Housing l = 115	1	Steel 3
4.	Blank flange	1	Steel 3
5.	Nut M 16 GOST 690951	6	Steel 3
6.	Pin M 16 l = 50	6	Steel 5
7.	Flange	1	Steel 3
8.	Packing 150/26, 5 - 8 mm	1	Rubber
9.	Bolt M 10	6	Steel 5
10.	Washer	1	Steel 3
11.	Sealing ring	1	Polyethylene, leather, rubber
12.	Saddle	1	Stainless steel
13.	Valve	1	Steel 3
14.	Pin No. 12	1	Steel 5
15.	Housing of hydrant l = 280	1	Steel 3
16.	Ring	1	Steel 3
17.	Flange	1	Steel 3
18.	Protecting tube, l = 150	1	Steel 3
19.	Plunger ø 20, l = 150	1	Stainless steel
20.	Packing 120/20, δ = 5mm	1	Rubber
21.	Pin M 10, l = 40	6	Steel 5
22.	Nut M 10 GOST 5909	6	Steel 3
23.	Riser	1	Steel 3

This fire hydrant is intended for installation in manholes or conduits. The housing of the hydrant is attached to the side of the pipe (see page VIII-6). There are two ways of installing the hydrant.

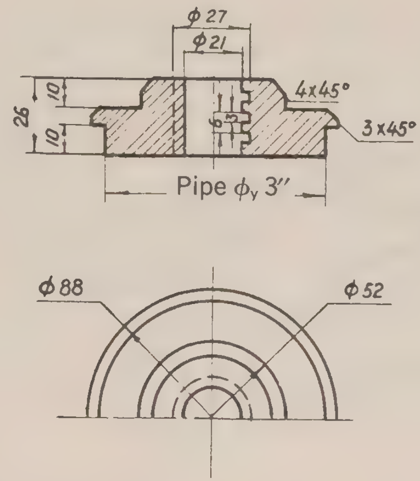
1. The layout of the area and traffic permit the installation of the riser and valve control above the surface of the ground. In this case the branch pipes with fittings for the fire hoses are welded horizontally to the riser.

2. The traffic conditions necessitate the installation of the riser and valve control below the cover of a manhole. The branch pipes with fittings are installed vertically and are welded to the riser to form an elbow. The hydrant does not freeze up. It does not require a stand. Because of small screw pitch on the spindle, the valve may be closed smoothly without hydraulic shocks. This is also facilitated by the conical shape of the valve. The hydrant is sealed not only by force of the spindle but also by water pressure in the pipe. This principle may be used also in other structures where water is discharged periodically, for example in water towers for steam locomotives and tank trucks.

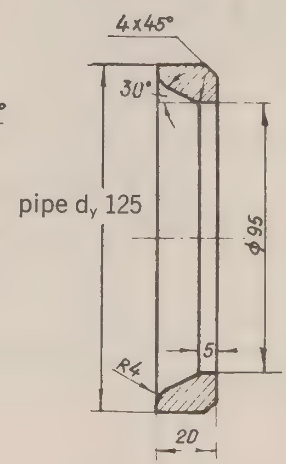
Spindle



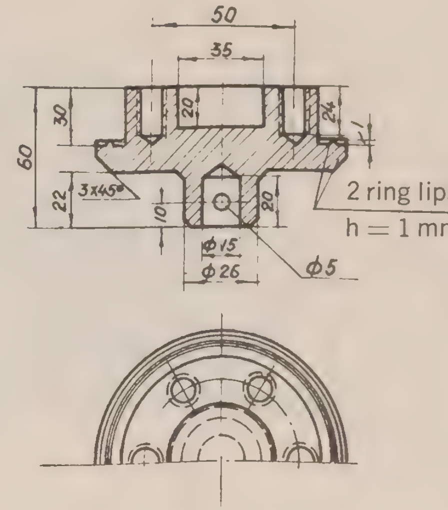
Nut



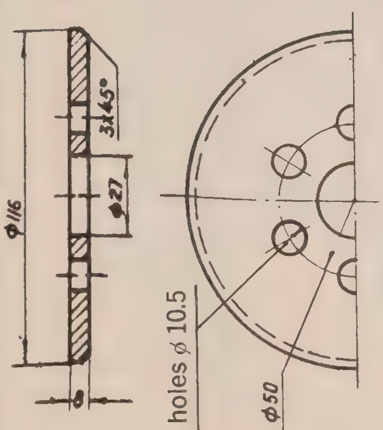
Valve saddle



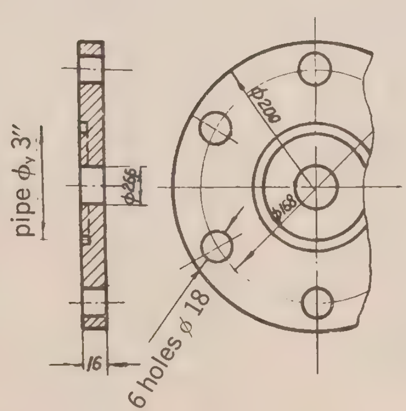
Valve



Washer

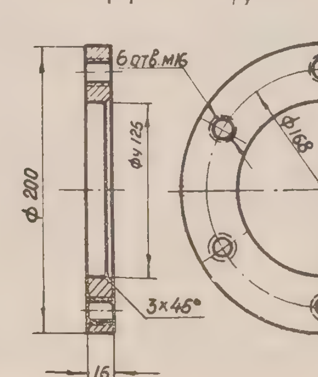


Flange

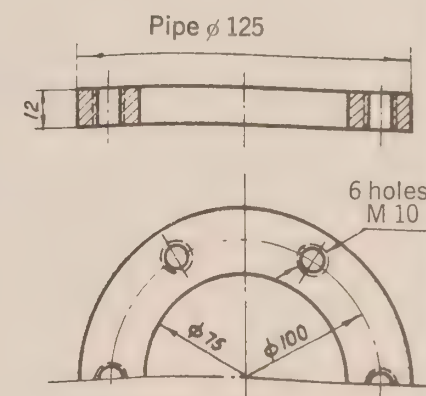


Flange

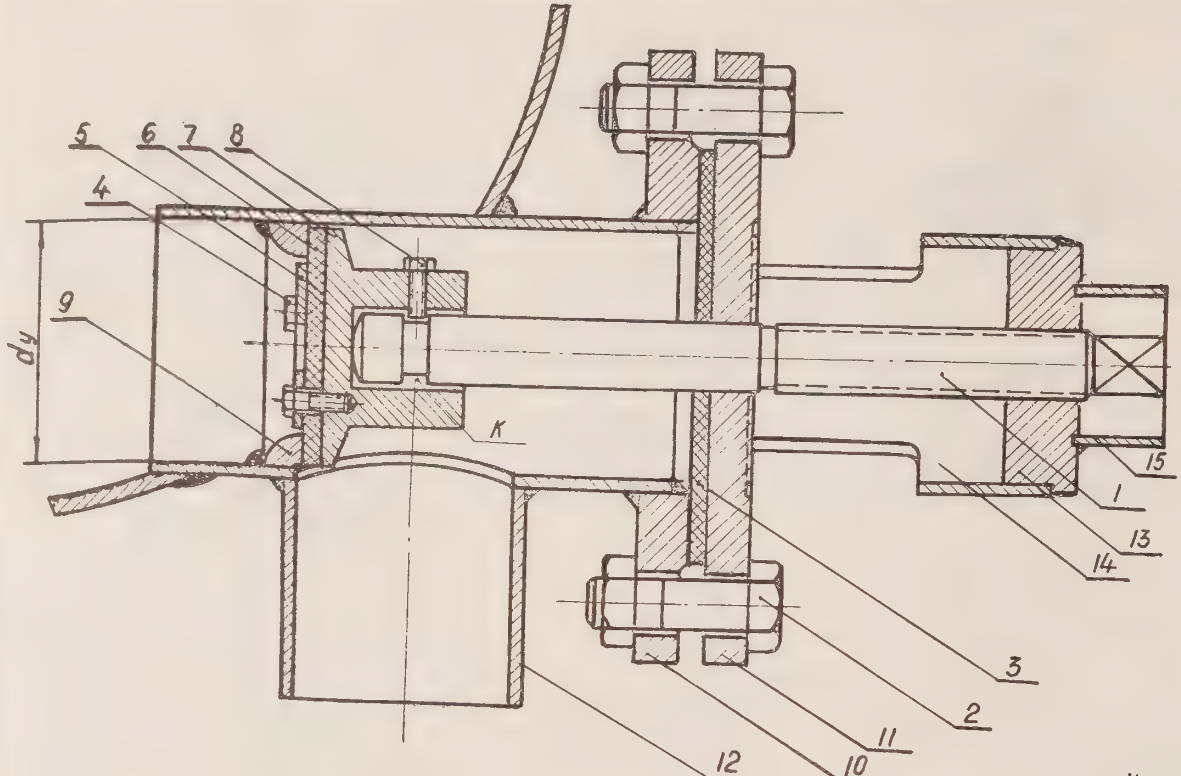
outside pipe diam ϕ_y 125



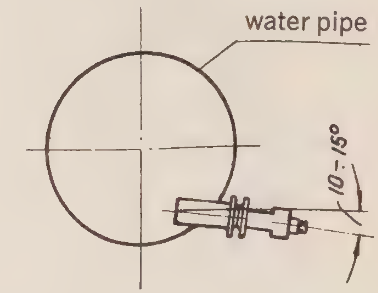
Ring



Non-freezing water connection	VII – 9



Mode of attachment



The blueprints may be obtained from the design office at the Noril'sk mining and metallurgical combine.

d_y	Blueprint No.	d_y	Blueprint No.
50	169 778	150	169 770
75	169 758	200	169 771
100	169 769	300	169 772

The outlet housing is installed in an inclined position as shown above. Space "K" must be filled with grease.

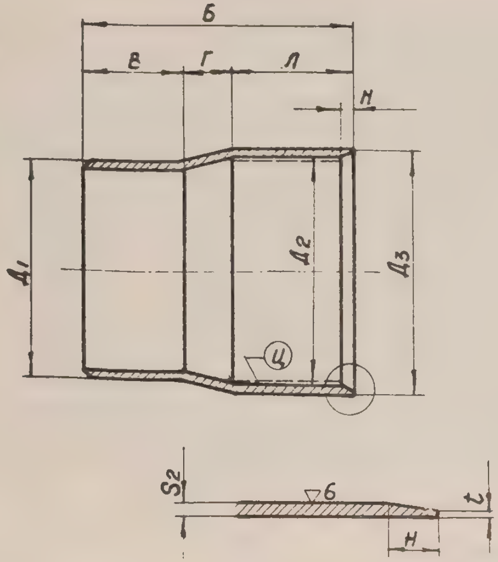
	Item	No.	Material
1.	Spindle	1	Stainless steel
2.	Bolt	4	Steel
3.	Packing	1	Rubber
4.	Bolt	3	Steel
5.	Washer	1	Steel
6.	Packing	1	Rubber
7.	Valve	1	Steel
8.	Bolt	1	Steel
9.	Saddle	1	Stainless steel
10.	Flange	1	Steel
11.	Flange	1	Steel
12.	Branch pipe	1	Steel
13.	Nut	1	Steel
14.	Branch pipe	1	Steel
15.	Protecting housing	1	Steel

Self-sealing expansion joint designed by A. V. Lyutov

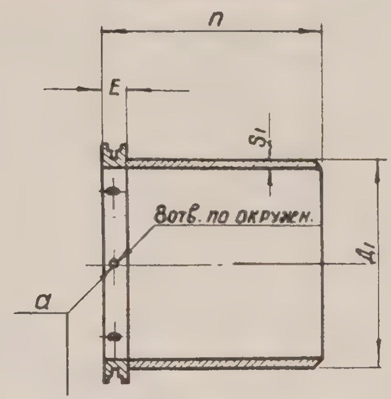
VII – 10

mm

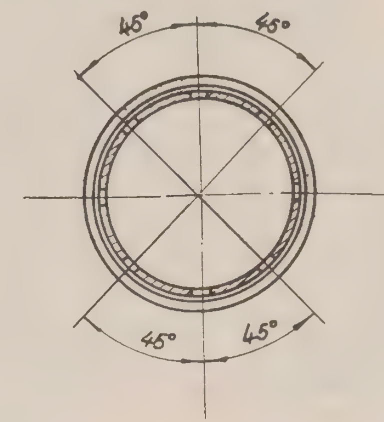
Housing



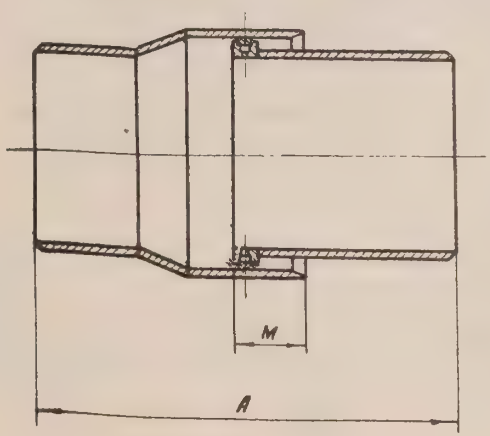
Casing with branch pipe



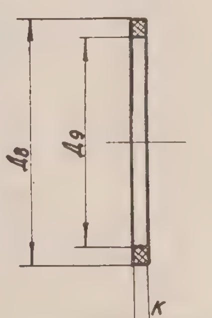
8 holes along the circumference



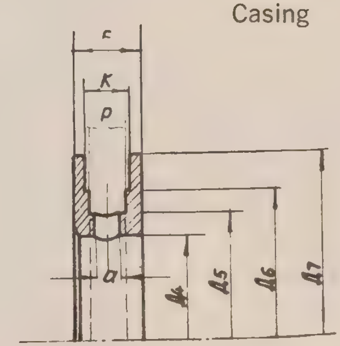
Assembled expansion joint



Elastic ring



Casing



D_y	Branch pipe			Housing										Casing								Rings	
	A_1	S_1	n	A_1	A_2	A_3	S_*	S_2	r	A	$Б$	H	t	E	K	P	a	A_4	A_5	A_6	A_7	A_8	A_9
150	168	6	250	168	231	241	7	5	100	300	600	40	3	36	24	18	12	160	185	195	$225^{-0.5}$	235	195
200	216	6	250	216	256	266	7	5	100	300	600	40	3	36	24	18	12	194	206	218	$250^{-0.5}$	260	218
300	325	6	300	325	410	426	11	8	150	300	750	40	3	38	26	19	14	314	344	364	$404^{-0.5}$	416	364
400	426	7	400	426	513	533	13	10	200	300	800	40	3	40	28	20	16	412	440	461	$507^{-0.5}$	519	467
500	529	7	500	529	613	639	16	13	200	350	850	40	3	42	30	22	16	515	540	560	$607^{-0.5}$	621	560
600	631	9	500	631	702	728	16	13	200	350	850	50	3	44	32	24	18	610	630	650	$696^{-0.5}$	710	650
700	720	10	600	720	802	828	16	13	200	350	950	50	4	44	32	24	18	700	728	748	$794^{-1.0}$	812	748
800	820	11	700	820	900	930	18	15	200	400	1000	50	4	50	34	26	18	800	824	844	$890^{-1.0}$	910	844
900	920	12	800	920	1000	1034	20	17	200	400	1000	60	4	52	36	28	18	900	920	940	$988^{-1.0}$	1010	940
1000	1020	13	900	1020	1100	1134	20	17	200	450	1100	60	5	56	40	28	20	995	1016	1036	$1086^{-1.0}$	1110	1036
1100	1120	14	1000	1120	1200	1234	20	17	200	450	1150	60	5	56	40	28	20	1095	1116	1136	$1186^{-1.0}$	1210	1136
1200	1220	14	1100	1220	1300	1336	22	18	200	500	1250	60	5	56	40	28	20	1195	1216	1236	$1284^{-2.0}$	1310	1236

*prior to machining

The blueprints of self-sealing expansion joints for all diameters from 150 to 1,200 mm have been published by the design office at the Noril'sk combine in accordance with the patent No. 148980, class 47f 1520, issued to A. V. Lyutov.

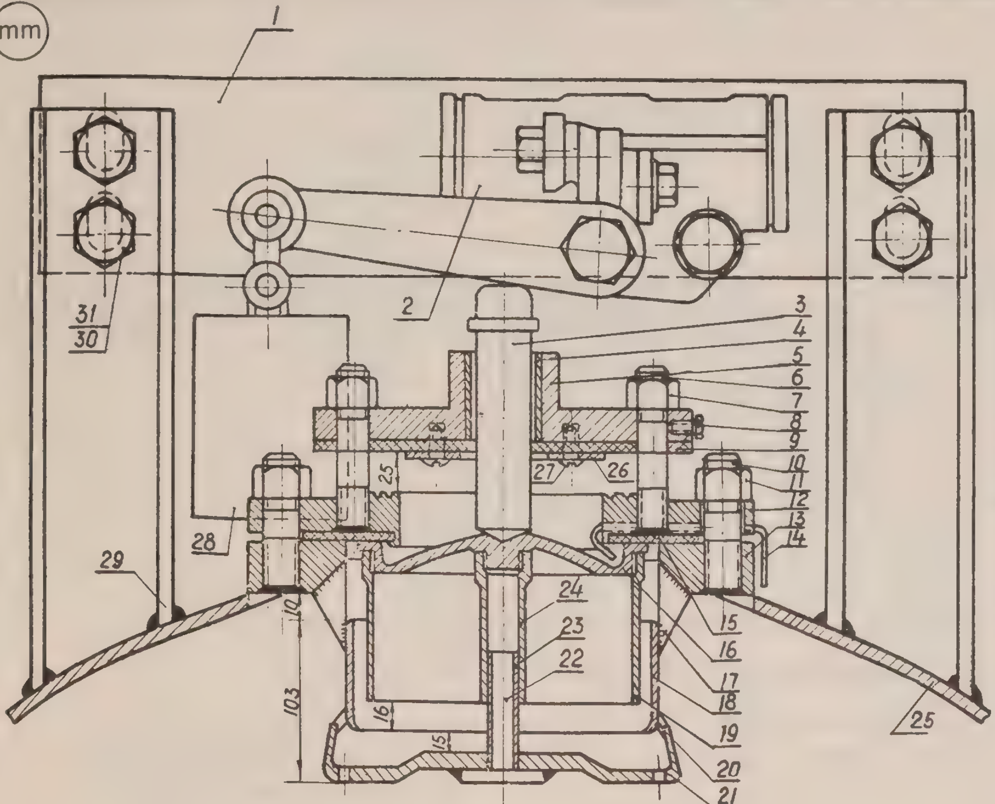
D_y	Blueprint No.	M	A	Weight kg
150	160 189	200	730	32
200	160 154	200	690	35
300	160 155	200	880	80
400	160 156	200	1030	160
500	160 157	250	1150	202
600	160 158	250	1150	210
700	160 159	250	1300	286
800	160 160	300	1550	395
900	160 161	300	1550	533
1000	160 162	350	1750	695
1100	160 163	350	1900	820
1200	160 164	400	2050	975

The expansion joint has been described in "Stroitel'stov raionakh Vostochnoi Sibiri i Krainego Severa", No. 3, Krasnoyarsk, 1962 and "Vodosnabzhenie i sanitarnaya tekhnika", No. 2, 1964.

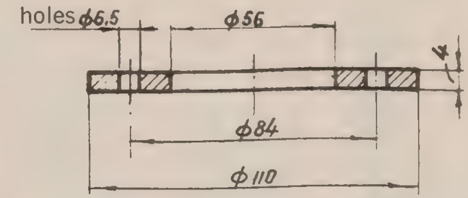
Air vent with shock absorber (designed by V. A. Kudoyarov)

VII — 12

(mm)

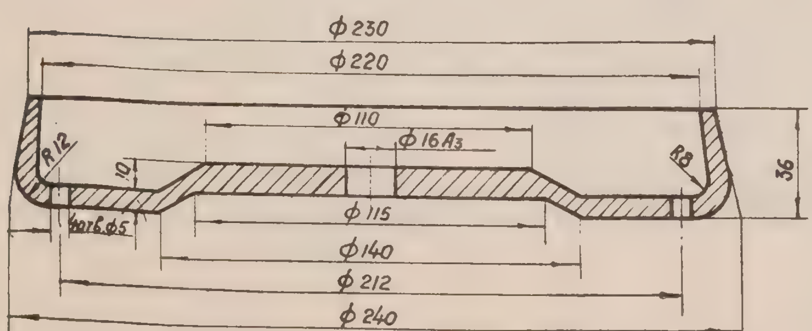


Clamp

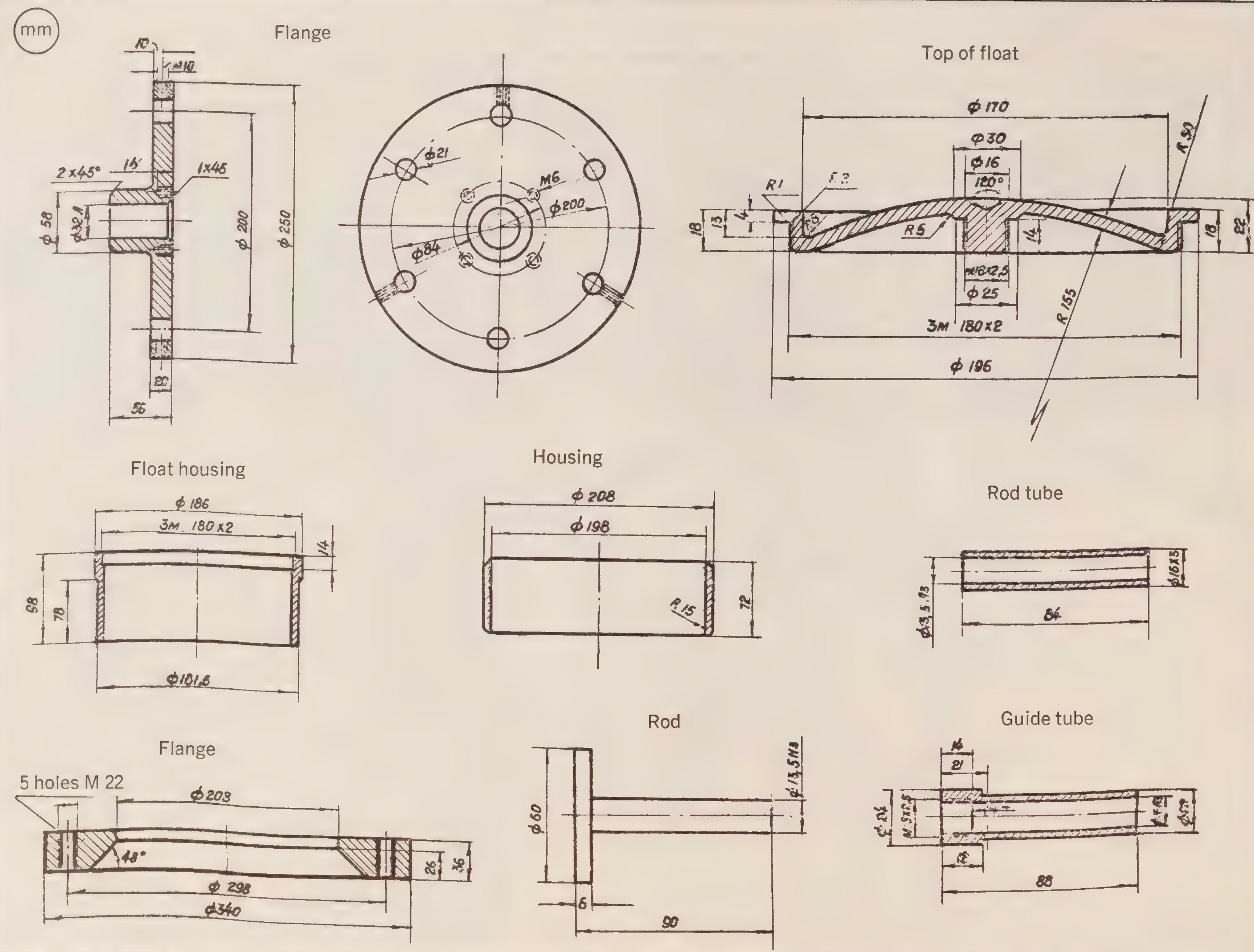


No.	Item	No.	Material
1	Channel beam No. 12, $l = 630$	1	Steel
2	Automotive shock absorber	1	Steel
3	Rod	1	Stainless steel
4	Bushing	1	Brass
5	Flange	1	Steel
6	Pin M 20, $l = 100$, $l_o = 32$	6	Steel
7	Nut M 20, $h = 20$	6	Steel
8	Lock screw M 10, $l = 16$	3	Steel
9	Packing 250/25 $\delta = 6$	1	Rubber
10	Pin M 22, $l = 86$, $l_o = 35$	6	Steel
11	Nut M 22, $h = 20$	6	Steel
12	Flange	1	Steel
13	Flange	1	Steel
14	Siphon tube	1	Brass
15	Packing ø268/140 $\delta = 6$	1	Rubber
16	Top of float	1	Stainless steel
17	Corner plate	4	Steel
18	Housing	1	Steel
19	Float housing	1	Steel
20	Sliding block	4	Steel
21	Housing tray	1	Steel
22	Rod	1	Stainless steel
23	Rod tube	1	Brass
24	Guide tube	1	Brass
25	Pipe	1	Steel
26	Clamp	1	Steel
27	Screw M 5, $l = 20$, $l_o = 10$	6	Steel
28	Weight	1	Steel
29	Support No. 10	1	Steel
30	Bolt M 18, $l_o = 20$	4	Steel
31	Nut M 18, $H = 14$	4	Steel

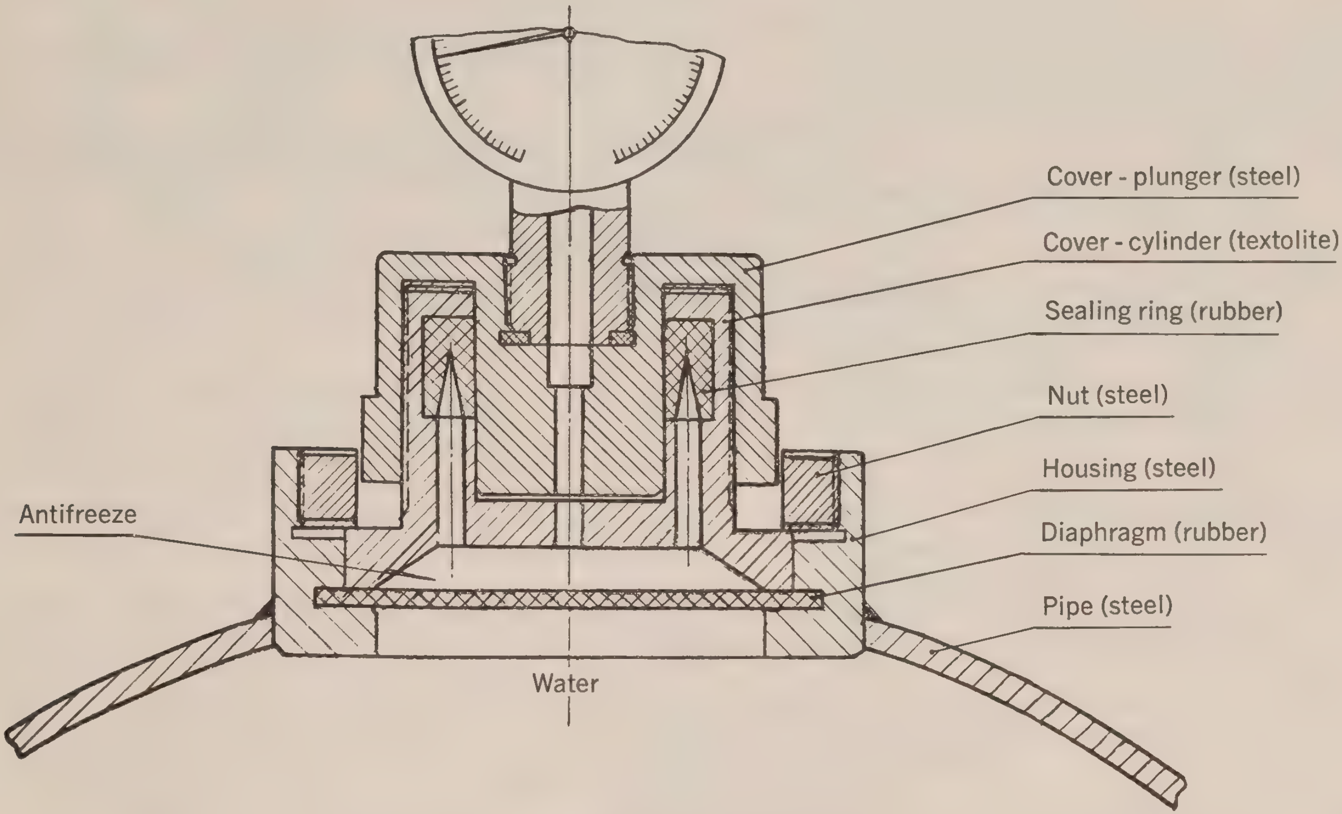
Housing tray



4 holes ø 5


mm
Flange
2 x 45°
1x46
φ 58
φ 200
φ 250
φ21
M6
φ200
φ84
56
Top of float
φ 170
φ30
φ16
120°
R1
R5
R 30
R 155
M18x2,5
φ 25
3M 180x2
φ 196
Float housing
φ 186
3M 180x2
φ101,6
Housing
φ 208
φ 198
R 15
Rod tube
84
Flange
5 holes M 22
φ 203
48°
φ 298
φ340
Rod
φ 60
90
Guide tube
21
88

Manometer stand (designed by A. V. Lyutov and A. A. Vershinin) | VII – 14



1. This device allows the water pressure in the pipe to be measured using a manometer.

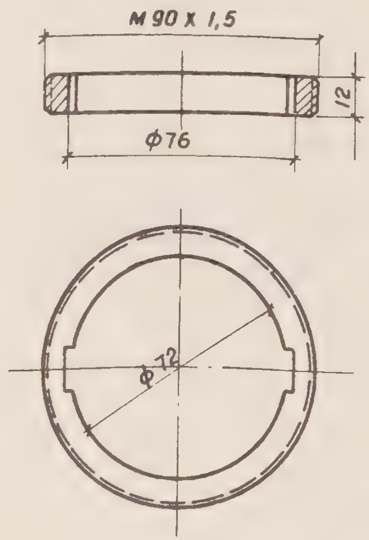
2. The manometer may be installed or removed under pressure.

3. The device is filled with antifreeze.

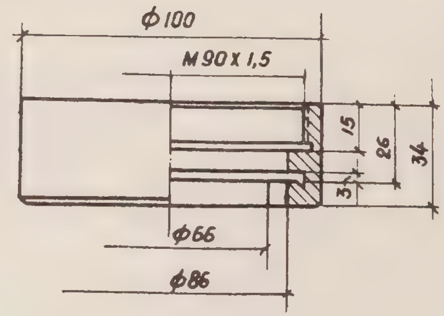
4. When the manometer and the plunger are removed, a protective cover is screwed on top of the cylinder.

mm

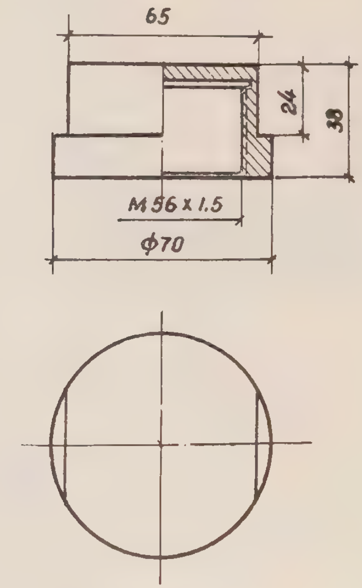
Nut



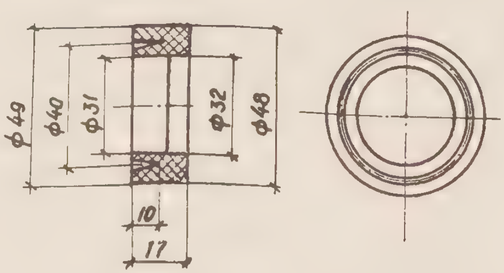
Housing



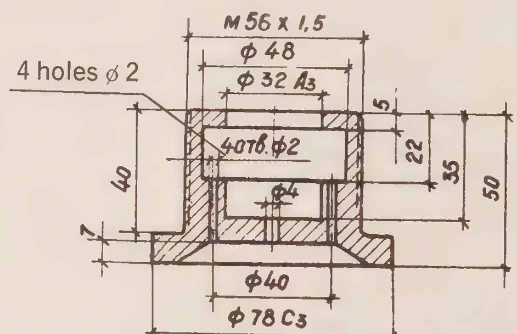
Cover



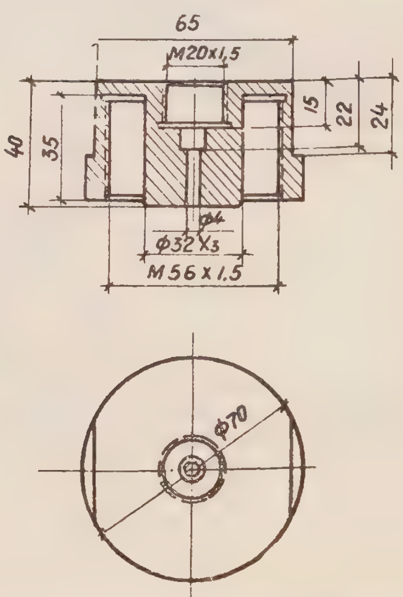
Sealing ring



Cover - cylinder



Cover - plunger



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